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THE CONCRESCENCE THEORY OF THE VERTEBRATE EMBRYO.

BY CHARLES-SEDGWICK MINOT.

THIS article, and the one to follow, owe their form to the fact that they have been written as chapters in my *Treatise on Human Embryology*. As this work cannot be published for some time to come, and as the chapters present certain views which are fundamentally different from those currently received by embryologists, I publish them separately. I believe that the right understanding of the early development of vertebrates depends upon the acceptance of Prof. Wilhelm His's view of concrescence. This view has not received the attention it deserves, for it is not based upon elaborate reasoning, but upon the direct observation of the process of concrescence in sundry vertebrates.

Incidentally it will appear that in my opinion neither Hertwig's Cœlomtheorie, nor Rabl's Theorie des Mesoderms, can be maintained for vertebrates; both of these theories involve the assumption that the vertebrate mesoderm arises as two lateral masses. This is true of no vertebrate; on the contrary there is probably hardly another fact in embryology so certainly established by innumerable observations as the fact that the vertebrate mesoderm *arises* as a single axial structure. It is only secondarily by the down-growth of the medullary groove and the up-growth of the notochord, that the mesoderm is divided by the meeting of these structures into two lateral masses. As regards Rabl's

theory of the double origin of the vertebrate mesoderm, I think he would not have advanced that theory, had he not first fallen into the error of rejecting Prof. His's concrescence theory.[1]

That the fundamental difference between the mesothelium and mesenchym involved in the Cœlomtheorie cannot be maintained for vertebrates, I have pointed out elsewhere.[2] This impossibility has also been brought out afresh by the investigations of Bonnet, Ziegler, Strahl, Rabl, and others.

As briefly indicated in my article on Segmentation of the Ovum (AMERICAN NATURALIST, 1889, June and September), the vertebrate *diaderm* (stage with ectoderm and entoderm only), advances to the next stage of development by the concrescence of the two halves of the ectental line to form the structural axis of the future embryo. The process is somewhat complex, and needs therefore to be described in detail, the more so as it has still to be traced in mammals.

Historical Note.—The earliest observations on concrescence to form the embryonic axis are, so far as known to me, those of Rathke on leeches.[3] Nine years later, Kowalewski (Mem. Acad. Sci., St. Petersbourg, 7th Ser., XVI., 1871), recorded its occurrence among insects. Its recognition as a vertebrate mode of development we owe to the brilliant investigations of W. His; in his first paper, *26*, he describes very accurately and clearly the process of concrescence in the salmon; in his second paper, *27*, he describes concrescence in the sharks, and in his third paper, *28*, he discusses again the general bearing of his results. Semper in his great work on the relationship of annelids and vertebrates, *54*, was the first to make a direct comparison of the processes of concrescence in annelids, insects, and vertebrates. Unfortunately Balfour entirely failed to grasp the new conception, and by expressing himself very decidedly against it, *Comp. Embryol.*, II., 306–308, led many embryologists to discredit

[1] Rabl's criticisms of His are very much to be regretted. If the former always observes with the precision and accuracy of the latter, he will add to his already high reputation.

[2] Buck's Reference Handbook, Med. Sci., III., 176.

[3] Rathke and Leuckart, Beiträge zur Entwickelungsgeschichte der Hirudineen, Leipzig, 1862.

the discovery. Whitman, *67*, 91–94, has ably defended the comparison made by Semper, see above. Rauber, *46*, Kollmann, *33*, Ryder and others, *50*, *51*, have added to our knowledge of the phenomenon. Duval's researches on the chick, *18*, demonstrate concrescence there also, though the author appears unacquainted with the results of his predecessors. Minot, in the article Fœtus, in Buck's Handbook, III., 172, 173, accepts concrescence as the typical mode of vertebrate development.

Concrescence in Bony Fishes.—At the close of segmentation the germinal disc forms a cap of cells on the yolk. The disc (primitive blastoderm) spreads over the yolk gradually; when it begins to spread its edge is already thickened; this thickened edge corresponds to the ectental line; the thickening is known as the *Randwulst;* it is also called the blastodermic rim, which term Ryder and others have used. When the blastoderm has spread so as to cover perhaps a sixth or less of the surface, one point of the rim ceases to move; consequently as the expansion continues, the edge of the disc bends in behind this point on each side, until two parts of the blastodermic rim meet, as they come from opposite sides, and then grow together. This is illustrated by the accompanying diagram, Fig. 1; *Y* is the outline of the yolk; *bl*, the outline of the blastoderm; *d* the fixed point; the expansion of the blastoderm has brought the parts 1, 1, together, and they have united; the parts 2, 2, are about to meet and unite; then 3, 3, will meet; 4, 4, and so on until the two halves of the ectental line are brought together along their entire length; their junction marks the axis of the future embryo, and produces a longitudinal band of thicker tissue, which has long been known to embryologists under the name of the primitive streak. The primitive streak in the

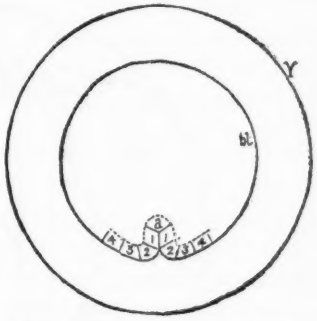


FIG. 1.—Diagram of vertebrate ovum seen from above to illustrate the power of concrescence: *Y*, outline of the yolk; *bl*, blastodermic rim; *a*, fixed point of rim.

anaminota is probably not identical with the so-called primitive streak of the amniota, but rather with the head process as explained later. The fixed point of the blastodermic rim marks the head-end of the embryo; the parts of the ectental line, which grow together next behind the fixed points develop into the head; those a little further back into the neck, and those further back into the rump and tail. The parts of the circular rim most remote from the fixed point, *d*, of course concresce last. The destiny of each portion of the ectental line is fixed before concrescence occurs. In fact in certain cases the differentiation of the tissues advances to a considerable degree in

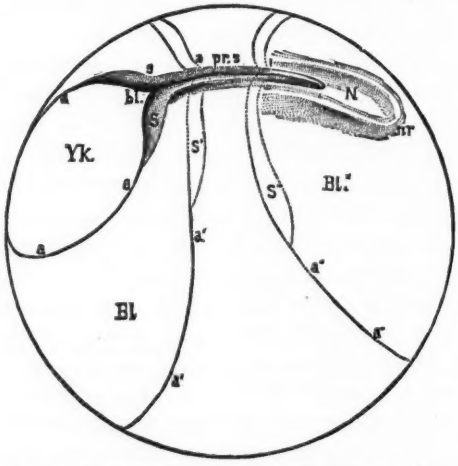


FIG. 2.—Diagram illustrating the growth of the blastoderm, and concrescence of its rim to form the primitive streak, *pr. s.* *N*, neural or medullary groove; *nr*, neural ridges; *Bl*, blastoderm; *S*, part of the blastodermic rim, termed the sichel in German; *pr. s*, primitive streak, *bl*, blastopore; *Yk*, uncovered yolk. Compare also the text.

the Randwulst before concrescence. This is strikingly the case in Elacate, in the ova of which the myotomes (or segmental divisions of the mesoderm) appear in the embryonic rim before its concrescence. (Ryder, 1885, *51;* compare also Ryder's observations on Belone, *49*.)

The accompanying diagram may assist to render clear the process of concrescence, Fig. 2. It is intended to illustrate the

spreading of the ectoderm (germinal disc, blastoderm, *auct.*) over the yolk, and the simultaneous formation of the primitive streak. The whole ovum is represented as seen in projection; the proportions are such as have been suggested by the ova of flounders and frogs. Three successive stages of the expanding blastoderm are represented; the first position of the embryonic rim (ectental line) corresponds to the dotted line, *a'' a'';* the concrescence reaches only to the point marked 1; the lateral margins, *s''*, which are to concresce later, still form part of the edge of the blastoderm. At the next stage the ectoderm has grown very much, and has moved its edge to *a'*, *a'*, while the margins, *s*, have coalesced so that the primitive streak extends to 2. The extension continues, bringing the ectental line to *a*, *a*, *a*, *s*, and carrying the primitive streak back to 3; behind the primitive streak a small area, *Yk*, of the yolk is still uncovered, and corresponds to the so-called anus of Rusconi in frogs' ova. The portion of the ectental line bounding this area differs from that which is immediately concerned in the formation of the primitive streak, *s;* although it now lies behind the primitive streak, it was previously in front of it, when the blastoderm covered only the minor portion of the ovum. (See *s'', a'' a''*.) Ultimately the yolk is entirely covered by the blastoderm, thus fixing the length of the primitive streak. It is essential to notice that the blastodermic rim (ectental line) divides into two portions, one, *s*, which forms the primitive streak, and another, *a''*, *a''*, which overgrows the ovum and at last closes over the yolk behind the completed primitive streak. That the processes are essentially as described becomes evident upon examination of the figures given by W. His, *26*, Kupffer, *39*, Coste, *14*, and others.

Underneath the entire length of the band of cells constituting the primitive streak is formed a cavity, which is transformed ultimately into the cavity of the alimentary canal and its appendages. It is termed the archenteron or entodermic canal (*Urdarm*). The mode of concrescence in elasmobranchs elucidates the formation of this cavity. In bony fishes the cells which form the walls of the archenteron lie so close together that the lumen of the canal

is obliterated and does not appear until considerably later (*cf.* Balfour, Comp. Embryol., II., 75.)

Concrescence in Elasmobranchs—Our knowledge rests mainly on the researches of His., 27, and his follower Kollmann, 33. Fig. 3, *A*, is a generalized diagram of an elasmobranch ovum, representing the ectodermal disc, *Bl*, as seen from above, resting upon the yolk, which is not represented in the figure.

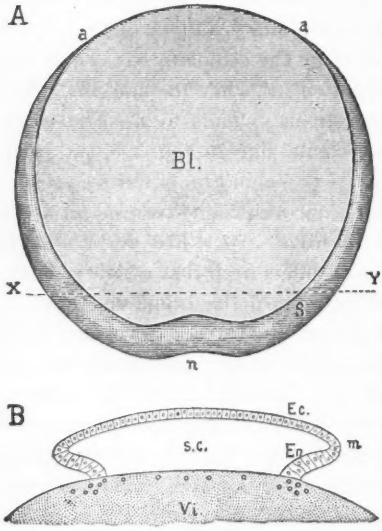


FIG. 3.—Diagram of an elasmo branch blastoderm to illustrate the formation of the marginal groove. *A*, surface view; *Bl*, blastoderm; *a*, *a*, anterior grooveless margin; *S*, (*Sichel*) marginal groove; *n*, marginal notch; *X*, *Y*, line of sections; *B*, section along the line *X*, *Y*, of *A*; *Ec*, ectoderm; *En*, entoderm; *m*, ectental line; *s. c.*, segmentation cavity; *Vi*, yolk with nuclei.

The first change noticeable in the disc after the close of segmentation is a groove running completely around its margin, between it and the yolk; as the disc grows and expands, the groove is no longer present along the front edge, *a*, *a*, of the blastoderm, but only on the sides and behind. About the same time there usually appears a distinct notch, *n*, which marks the fixed point of the margin, and the posterior end of the disc. If, now, a section be made across the line, *x*, *y*, the relations will be found to be essentially as represented in the diagram, Fig. 3, *B*; the disc rests on the yolk, *Vi*, which contains numerous nuclei; between the yolk and the ectoderm, *Ec*, is the segmentation cavity, *s. c.*; the groove is bounded above by a layer of cells, *en*, which are larger than those of the ectoderm, and have been produced by the yolk, *Vi*; sometimes there are cells lying in the segmentation cavity at this stage, the formation of the mesoderm having already begun. The essential point to note in this stage is, as Kollmann has

shown, the division of the margin of the ectodermal disc into two parts, one, *a*, *a*, resting directly on the yolk, the other *s*, directly continuous with a layer of entodermal cells, *B*, *En*, forming a little groove under the margin of the disc. The two portions of the ectental margin have entirely distinct functions, as already stated: the interior, *a*, *a*, is destined to grow over and cover the

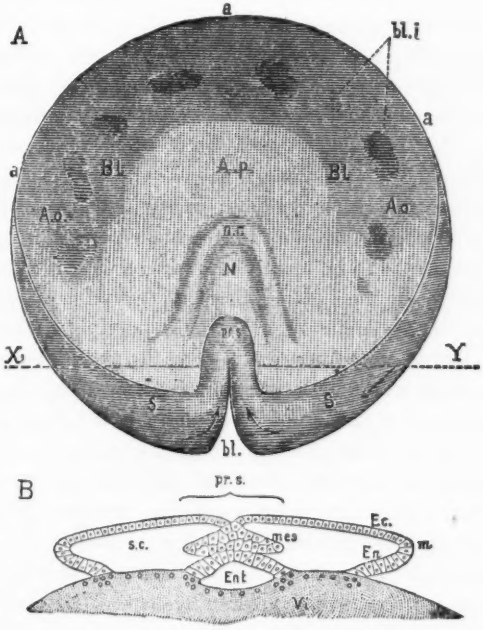


FIG. 4.—Diagram of a vertebrate blastoderm a little more advanced than Fig. 3.—*A*, surface view; *B*, section along the line *X*, *Y*; *Bl*, blastoderm; *a*, *a*, *a*, anterior margin *s.s.*, posterior margin (Sichel); *A. o.*, area opaca; *A.p.*, area pellucida; *n.r.*, neural ridges; *N*, neural or medullary groove; *pr.s.*, primitive streak; *bl*, blastopore; *Ec.*, ectoderm; *m*, ectental margin; *En.*, entodermic cells; *Vi*, yolk; *mes.*, mesoderm; *s.c.*, segmentation cavity.

yolk by the extra-embryonic portion of the ectoderm: the posterior, *S*, is destined to form the primitive streak of the embryo.

Fig. 4 is similar to Fig. 3, but represents a more advanced stage. The ectodermal disk, *Bl*, is much enlarged, and its anterior grooveless margin, *a*, *a*, *a*, is relatively much more increased than

the posterior grooved margin *S;* the centre of the notch, Fig. 3, *n* has remained nearly if not quite stationary, Fig. 4, *pr.s.*, while the margin, *s. s.*, of either side has been growing toward its fellow in the manner indicated by the arrows, and as they meet the two side margins grow together in the median line, making a longitudinal structure. The manner and results of the concrescence of the margins from the two sides to form a median longitudinal structure, become clearer in section, Fig. 4, *B.* The margin at the side, *m*, still shows the same relations as in Fig. 3, *B;* in the median line, however, the margins have met and intimately united, so that what were originally two grooves have completely united to form a single canal, *Ent*, bounded above by entodermal cells, below by the entodermal yolk, *Vi.* This canal is the primitive entodermal cavity. A moment's consideration renders it evident that the canal must be open posteriorly; this opening is the blastopore, *bl.* There are some further details to be mentioned; where the ectental margins have united in the median line, there appears a lateral outgrowth, *mes*, which is the beginning of the mesoderm; in some cases this mesodermic tissue appears before the margins concresce; when viewed from the surface the mesoderm can be seen through the ectoderm, as was observed long ago; it is this faint appearance which early writers call the primitive streak, it being the foreshadowing of coming organization. In the middle line there appears a little furrow known as the primitive groove, perhaps the homologue of the ciliated ventral furrow of annelids. The Fig. 4, *A*, also shows *in front of* the primitive streak the first trace, *N.*, of the central nervous system. The blastoderm is seen also to be divided already into two parts, the lighter area pellucida, *A. p.*, and the darker area opaca, *A. o.;* the latter also shows the first blood islands.

From their observations, His, Kollmann and others have inferred that at the anterior ectental margin, *a*, *a*, *a*, there are produced (from the yolk) cells, which grow in toward the embryo, and constitute part of the mesoderm, and are especially concerned in forming the first blood, which is produced always in the extra-embryonic area. This mesoderm of peripheral origin His has named parablast, a term which unfortunately has been employed

differently by some subsequent writers. The ectoderm, entoderm, and axial mesoderm Prof. His groups under the collective name of archiblast. This view of the double origin of the mesoderm, although it has been adopted in a modified form by the brothers Hertwig, I am unable to accept.

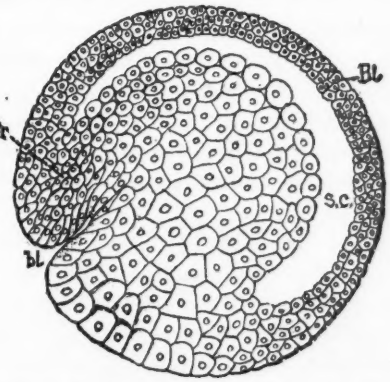


FIG. 5.—Ovum of axolotl; after Bellonci; longitudinal section to show the commencing formation of the primitive streak; *bl*, blastopore; *Bl*, blastoderm; *s.c.*, segmentation cavity.

Concrescence in Marsipobranchs, Ganoids and Amphibians. — As not only the constitution of the ovum, but also its early development, is very similar in the three classes named, we may consider them collectively in the present connection. The condition of the ovum at the close of segmentation I have already described,[3] p. 472 and figured, Fig. 4, *3*. The ectental line is not sharply defined, nor does there appear any groove around the edge of the blastoderm as in meroblastic ova. The small-celled ectoderm spreads over the yolk; while it is doing this a small cavity appears at the hind edge of the blastoderm, with a small opening to the exterior known as the blastopore, Fig. 5, *bl.*; the cavity runs forwards towards the segmentation cavity Fig. 5, *sc.*; above and in front of the blastopore the cells have multiplied and accumulated to form the beginning

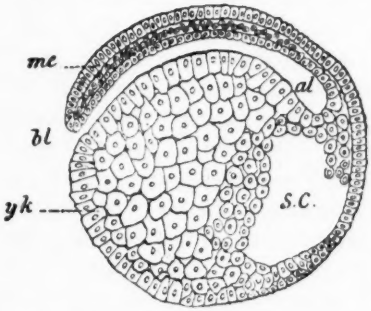


FIG. 6.—Ovum of Petnmyzon in longitudinal section, after Balfour.

[3] AMERICAN NATURALIST, 1889.

of the primitive streak, *Pr.* In the lamprey there is at this stage no such accumulation of cells; according to Shipley the ectoderm consists of a single layer of cells and the archenteron is bounded on its dorsal side by a single layer of cells also, between which and the overlying blastoderm there are no cells; the gathering of cells, corresponding to the primitive streak, does not arise until later. The cavity becomes that of the anterior end of the archenteron; it is sometimes designated as the blastoporic invagination. The archenteron, in the same measure as the blastoderm spreads over the yolk, grows at its hinder end away from the segmentation cavity, Fig 6, just as in elasmobranchs. A stage is soon reached in which nearly the entire length of the archenteron is formed, and nearly the whole yolk is covered. There is still a blastopore which leads into the cavity, and which has moved gradually backwards from its original position. Behind the blastopore lies the uncovered yolk, which in the frog's ovum is very conspicuous, because its whitish color contrasts with the dark color of the heavily pigmented ectoderm around it; this area of exposed yolk is the so-called anus of Rusconi. When the archenteron has completed its full length, the following disposition of the parts is found, Fig. 7. The archenteron is bounded below by the large mass of yolk cells, *vi*, and above by the epithelium, *ent*, of the entoderm; its posterior end curves up to open at the blastopore, *Bl*, passing through a mass of cells, which constitutes the hind end of the primitive streak; this portion of the archenteron is sometimes called the blastoporic canal. There is further a short prolongation, *Al*, of

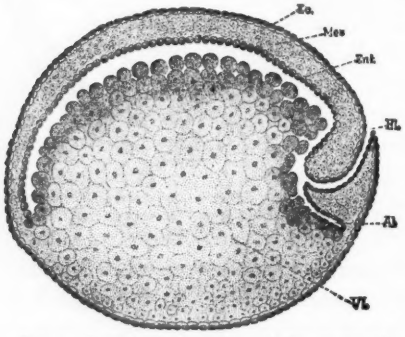


FIG. 7.—Longitudinal section of the ovum of a sturgeon after the formation of the entodermic cavity. *Ec*, ectoderm; *mes*, mesoderm; *Ent*, entoderm; *Bl*, blastopore; *Al*, diverticulum of the archenteron; *Vi*, yolk (after Salensky).

the cavity below the blastopore. This diverticulum has been homologized with the allantois. It is also very probably homologous with the more nearly spherical diverticulum found in a similar position in teleosts, and now known as Kuppfer's vesicle, from having been especially studied by C. Kuppfer, *34*, *35*, who has interpreted it as the teleostean allantois. Compare D. Schwarz, *53*, 197, Taf. XIII., Figs. 35, 37, etc. Around the blastopore is a mass of cells, continuous on the one side with the ectoderm, on the other with the epithelial entoderm lining the archenteron, and thirdly with a sheet of cells, *mes*, between the ectoderm, *ec*, and entoderm, *ent*.

The developmental phases just outlined seem to me to afford sufficient evidence of concrescence. Owing to the gradual transition between the ectoderm (blastoderm) and the entoderm (yolk cells), there is no sharp ectental line as in some types. Moreover there is no differentiation of the tissues at the blastodermic rim, but only after the cells are united in the axis, hence we cannot distinguish parts at the periphery of the blastoderm and follow their union in the primitive streak as we can in certain sharks and bony fishes. Nevertheless we find all the essential features of concrescence; the entodermal canal and the primitive streak begin at the edge of the blastoderm and grow at their posterior end away from the segmentation cavity and at the same rate the blastoderm overspreads the yolk.

Concrescence in Sauropsida.—The early development of the reptilian ovum is imperfectly understood, although several valuable memoirs have been published upon it. The ova present the peculiarity that the posterior end of the primitive streak is a solid mass, the blastoporic canal being closed until a quite advanced period, when it is temporarily opened. (Compare the section on the *Blastopore*.) It seems to me that the archenteron is formed by concrescence, in spite of the modified history of the blastoporic canal. Not only does the primitive streak begin its development at the edge of the primitive ectoderm (blastoderm or germinal disc) and grow backwards, but also the ectodermal cavity is formed underneath it, but there is no open blastopore so far as yet observed. This growth of the primitive streak and groove are very clearly

demonstrated in C. Kuppfer's figures, *36*, Taf. VIII., Figs. 1-3. Moreover, Kuppfer and Benecke have found, in certain cases, the so-called "Sichel," or transverse thickening at the hind end of the growing primitive streak; this thickening is a portion of the blastodermic rim, and by the interpretation I adopt until better observations shall decide, it corresponds to the transverse thickening in a similar position in sharks.

The process of concrescence in birds was partly indicated by Koller's investigations, *30*, *31*, and has been carefully elucidated by Duval, *18*, 1. The resemblance to concrescence as known in elasmobranches is very striking. Around the edge of the blastoderm appears very early a small groove; as the blastoderm expands the front portion loses the groove; one point, the centre of the groove, ceases to move, or at least moves much more slowly than the remainder of the blastodermic rim; as the expansion continues the edges of the two halves of the groove coalesce gradually behind the fixed point, thus producing the entodermal canal in the same manner as in sharks; cells accumulate at the same time and make the so-called primitive streak; most of these cells enter into the composition of the mesoderm. There is an uncertainty in Duval's account owing to his failure to distinguish between the segmentation and the entodermal cavities; as I have pointed out, AMERICAN NATURALIST, 1889, p. 475, Duval's subgerminal-cavity at the close of segmentation is the true segmentation cavity (blastocœle); his own account of the concrescence shows that the entodermal canal arises separately and behind the blastodermic or true segmentation cavity; but unfortunately neither his text nor his figures give satisfactory information in regard to the separation of the two cavities; Duval calls the entodermal cavity also the subgerminal, thus causing confusion, since subgerminal is properly applied only to the blastocœle.

In birds (hen's ova) there is a further peculiarity, which is, I think, probably to be found in all amniota, namely:—that portion of the edge of the ectoderm which does not share in concrescence, and which corresponds to the edge of the anus of Rusconi, closes over the yolk behind the primitive streak, so that

the portion of the yolk which is left uncovered is remote from the embryonic area (or primitive streak). As a rare anomaly (see Whitman, *68*), a line is visible running in the ectoderm from the hind end of the primitive streak to the edge of the uncovered yolk; this line is to be interpreted as evidence of the growing together of the ectoderm behind the streak proper. The ectoderm, as it spreads over the yolk, receives no accretions from it, but accomplishes its expansion by proliferation of its own cells. Thus the uncovered yolk is bounded by the free edge of the ectoderm; this area, which may be called the yolk blastopore,[5] is comparable to the anus of Rusconi, from which it differs in position, being remote from, instead of close (as in the anus of Rusconi) to the primitive streak, for it is situated nearly opposite the embryonic area. In birds, according to Duval, *19*, the yolk blastopore (Dotternabel) is never closed by ectoderm, but remains covered by the vitelline membrane only until the mesoderm spreads over it. The growing edge of the ectoderm is somewhat thickened; it finally is reflected around the edge of the yolk blastopore, forming as it were a funnel, at the bottom of which is the yolk. (See Duval, *l. c.*)

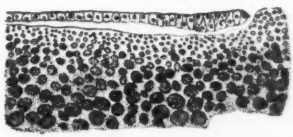


FIG. 8.—Hen's ovum; incubated six hours; anterior edge of the ectoderm, *Ec*, resting on the yolk, *Vi*; from a longitudinal section of the blastoderm in situ; after Duval.

Concrescence in Mammals.—There is, as yet, no direct evidence of concrescence in mammals, but strong indirect evidence. First, it is to be remarked that of no mammal do we know the exact history of the primitive streak, and secondly that what we do know accords fully with the history in the Sauropsida. There is a primitive blastoderm on the edge of which the primitive streak appears, and from its beginning the streak grows backwards as the germinative area expands. Now the mammals are derived from the reptiles, and it may be assumed safely that their early development is essentially the same as that of the reptiles, and what knowledge we possess agrees with this inference. Unfortu-

[5] Duval applies to it the name of ombilic ombilical.

nately the few authors who have investigated the primitive streak in mammals have failed to consider the problem, as the discoveries of His and his followers have rendered it necessary to consider it, namely, as the question: How is concrescence modified in mammals? It is therefore not surprising that we lack the necessary information. The organization of the mammalian primitive streak is described below. Provisionally, at least, we must assume that the streak follows the same developmental type in the highest as in the lower vertebrates.

Concrescence, Summary.—The evidence that concrescence is the typical means of forming the primitive streak in vertebrates is: (1) detailed and conclusive observations upon elasmobranchs, teleosts and birds; (2) exact and extensive observations on marsipobranchs, ganoids and amphibians, which concord with the theory of concrescence; (3) a great probability of its occurrence in reptiles, owing to the similarity of their development with that of birds; (4) a probability of its occurrence in mammals, because of the resemblance in the growth and structure of the primitive streak to that in other vertebrates. It seems to me therefore not premature to draw the generalization that *the vertebrate primitive streak is formed by the growing together in the axial line of the future embryo of the two halves of the ectental line.*

The development of the primitive streak may be described in general terms as follows:—At the close of segmentation the edge of the primitive blastoderm separates into two parts; one part (the anterior), as the blastoderm expands, spreads over the yolk, gradually covering it with ectoderm; the other part (the posterior) forms the primitive streak; it has in its centre one fixed point, consequently when the blastoderm expands the two halves of the posterior part of the ectental line are brought together, and gradually unite (concresce) along a line running from the fixed point radially backwards as regards the blastoderm. Consequently the segmentation cavity which is underneath the primitive blastoderm lies in front of the developing archenteron. While this goes on, cells grow out from the concrescing part of the ectental line into the space between the ectoderm and entoderm (or yolk); underneath the line of junction a cavity is

formed, lined by entoderm, having cells on the dorsal, yolk on the ventral side; this cavity with its walls is the archenteron; the archenteron lengthens backwards as concrescence progresses; it has, whatever its length, a small entrance (the blastopore) at its hind end; the blastopore is ultimately obliterated; it is found to be temporarily closed in (all?) amniota during the lengthening of the archenteron (and primitive streak). The cells which grow out from the ectental line constitute the first anlage of the middle germinal layer or mesoderm, and shining through the ectoderm they produce the appearance of a whitish line, which has led to the name of primitive streak. The characteristics of the mesoderm are described in the next section. Along the line of junction there often appears a slight furrow in the ectoderm, which is known as the primitive groove.

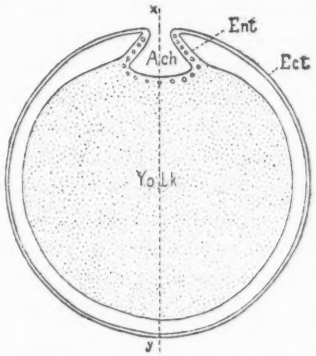


FIG. 9.—Diagram of a vertebrate embryo in which the lips of the gastrula mouth are supposed not to have concresced. *Ach*, archenteron; *Ent*, entoderm; *Ect*, ectoderm; *Yolk*, yolk-entoderm; *x-y*, gastrula axis.

Significance of Concrescence. It will at once be evident that if the process of concrescence went on without the actual meeting of the two portions of the ectental line the result would be to leave the archenteron open along its entire length; the borders of the opening would be the ectental line; and this line, as I have shown elsewhere (AMERICAN NATURALIST, 1889), corresponds to the lips of the gastrula mouth; consequently we should have a gastrula with an elongated mouth. This condition is illustrated by the accompanying diagram. It agrees in all respects with the gastrula type; its most noteworthy peculiarities are two:—*first*, the enormous mass of yolk accumulated in the aboral portion of the entoderm; *second*, the elongation of the gastrula or archenteric cavity in a direction at right angles to the gastrula axis, *Xy*. If now the lips of the gastrula, Fig. 9, meet, and unite we should obtain at once the vertebrate type, cf. Fig. 4, B. Accord-

ing to His's discovery this is precisely what takes place, only the lips are brought together first at one end, where they at once unite, while behind they are widely separated; but gradually they are brought together and unite throughout their entire length.

Concrescence is, then, a modified method of uniting the lips of a greatly elongated gastrula mouth. Why this modification is established we cannot say with certainty, though we may surmise with confidence that it is consequent upon the great accumulation of yolk in vertebrate ova.

The view here adopted enables us to speak positively as to the point where we are to look in vertebrates for the homologue of the invertebrate mouth. In annelids concrescence is very well marked whenever the ova contain much yolk; now in leeches and earthworms, the ectental line does not concresce along the entire axial line but on the contrary, as shown by Kleinenberg and Whitman, the foremost part of the germ bands (gastrula lips) do not unite but leave a small opening; when the permanent mouth is formed this opening is carried in and serves as the passage between the mouth cavity (Vorderdarm, stomodæum) and the archenteric cavity. The foremost part of the line of concrescence lies according to His' observations on fishes just where the optic outgrowths arise; hence we have to search between the origins of the optic nerves for traces of the invertebrate mouth.

(*To be continued.*)

THE PERSISTENCE OF PLANT AND ANIMAL LIFE UNDER CHANGING CONDITIONS OF ENVIRONMENT.[1]

BY PERSIFOR FRAZER.

DANA, in the Introduction to his Manual of Geology (1874), thus distinguishes between the Plant and Animal Kingdom, on the one hand, and the Crystal Kingdom on the other hand:

"The plant or animal, (1) endowed with life, (2) commences from a germ, (3) grows by means of imbibed nutriment, and (4) passes through a series of changes and gradual development to the adult state, when (5) it evolves new seeds or germs, and (6) afterwards continues on to death and dissolution. It has, hence, its cycle of growth and reproduction, and cycle follows cycle in indefinite continuance.

"The crystal is (1) a lifeless object, and has a simpler history; it (2) begins in a nucleal molecule or particle; (3) it enlarges by external addition or accretion alone, and (4) there is hence no proper development, as the crystal is perfect, however minute; (5) it ends in simply existing, and not in reproducing; and (6) being lifeless, there is no proper death or necessary dissolution."

In pursuing the subject more in detail this author states of both plants and animals that they "have the fundamental element of their structure, visible cells, containing fluid or plastic material, instead of invisible molecules."

As to this it may be said that while there are some reasons for believing, with our present knowledge of the nature of light, that the microscope will never reveal to us a single molecule, such a revelation is not at all impossible when one considers the gigantic strides which have been made in subduing the phenomena of nature to aid us in penetrating her secrets; but even if it be true that we shall never see a single molecule, it is not yet proven that a single molecule forms the unit of mineral building. There are

[1] An address delivered before the Pennsylvania Horticultural Society, May 20, 1890.

some reasons opposed to this view mentioned by Dr. Hensoldt in an interesting article on Crystallogenesis (*Am. Geologist*, May and June, 1890). If we could magnify objects 30,000 diameters, and not thereby reduce the illumination too much, we might see a single molecule. At present the limits thus far reached are some 1600 diameters. "But," Dr. Hensoldt says, "the particles of which crystals are composed can be clearly discerned with a $\frac{1}{10}$ inch objective,—very rarely in the finished crystal, but whenever a substance is examined under the microscope during the process of crystallization, and wherever the operation of crystalline forces can be observed under high powers of magnification. There are reasons for believing that each of these visible particles is an aggregate of molecules, just as a molecule is an aggregate of atoms, and that no single molecule is capable of manifesting polar forces of sufficient energy to enable it to play a part in crystalline economy. . . 'The angular hypothesis' which maintains that the fundamental force of a crystal is determined by the shape of its integral molecules, has very few adherents now . . . On the other hand, the spheroidal form of the planets, the tendency of fluids to assume the spherical shape and the mechanical facilities which the hypothesis of rounded particles offers in the grouping of molecules have induced later inquirers to adopt almost unanimously the views of Wollaston and Hooke. We are now in position to show . . . that molecules must be more or less spherical, and in the case of augmented molecules, . . . or the minutest parts of which crystals are composed, we have abundant direct proof of this, as their forms are revealed to us by a magnification of less than 1500 diameters."

Dana continues: "(2) The living being enlarges by means of imbibed nutriment through a process of evolution; and not by mere accretion or crystallization."

This use of "evolution" is vague, and an enlargement by other means than mere accretion is unsupposable. Whether the accretion is from without or within, exogenous or endogenous, there can be but one way of lengthening or widening or deepening an object, and that is by adding matter to it or by stretching further apart the particles of matter which it already has.

This is as true of a plant or animal as it is of a crystal, and until we learn what is the procedure in the act of growing manifested by plants and animals, we cannot assert that it is different from that in crystals. The framework of some living organisms is made up of minute crystals of carbonate of lime. It seems quite possible that the minutest component parts of either the cell or the perfectly visible crystal are crystalline, and that the next larger components, both in crystals and in organisms, are spheroidal bodies more or less resembling cells.

Another strong reason for believing that the smallest parts of organisms are crystalline in character, is the action upon them of polarized light.[2]

Without going more minutely into the explanation of these curious phenomena, it will be sufficient to say that bodies which are built up in such a manner as to exhibit greater density in one direction than another are said to be under the influence of polar forces of different degrees. Such building up is crystalline, and is apparent by the effect which the structure exerts on polarized light; and almost if not all organic solids show these effects.

Dana continues: "(3) It has the faculty of converting the nutriment received into the various chemical compounds essential to its constitution, and of continuing this process of assimilation as long as the functions of life continue; and it loses this chemical power when life ceases."

The crystal lives on what it can absorb from the liquids or semi-liquids, and from the gases surrounding it—probably never from the solids. In this it resembles the living thing.

Moreover, it separates out of a solution containing many things the materials which it needs to continue the growth of itself, and rejects the rest, either pushing them aside or enclosing them as foreign bodies within its own structure.

As to its losing this power when life ceases, the crystal's life or growth may be said to last so long as there is a menstruum in which it can derive material for its further accretions, and to cease when this menstruum is withdrawn. But it can be resumed

[2] As pointed out by the speaker in a lecture before the International Electrical Exhibition in 1884.

again at any time that it is placed under similar conditions, and in the meantime it may remain just as it was left when its growth ceased. This seems to me to offer a better distinction between the organic and inorganic than most others, viz: that when the force which produced the first and sustains it by constant replacement of matter ceases, it cannot again be resumed with the same results in the same being, but in the inorganic world this is possible.

Dana continues: "(4) The living being passes through successive stages in structure and in chemistry, from the simple germ to a more or less complex adult state, and finally evolves other germs for the continuance of the species; instead of being equally perfect and equally simple in all its stages, and essentially germless."

It would be expected that the crystal world would be found to resemble more nearly the less organized end of the organic world, and we should look for analogies to the simple amœbas. These are but drops of jelly in their simplest forms, which grow in size by absorption of what passes through them, and which break up into fragments, each of which becomes a new nucleus for a similar organism.

If these be considered germs, then the detached fragments of a large crystal which form new nuclei of similar crystals in a solution containing the materials out of which the chemical substance necessary to their being is obtained, are also germs. It is well to recall also that, though there may be innumerable other substances in the same solution than those entering into the formula of the crystallizing mineral, these latter will be excluded, and those which are necessary will be assimilated as truly as the stomach of animals or the organs of plants assimilate their nutriment.

In the more special distinctions which this author makes between plants and animals, there is nothing to arrest the conclusions which seem forced upon us by a consideration of the above general characteristics. These distinctions have relation to the absorption by the plant of carbonic acid, and by the animal of oxygen; of manufacturing organic food for the animal, by the

plant, from inorganic material; etc, etc., which do not concern the main question of the essential continuity of inorganic with organic force, and the separation of the phenomena of the latter from those of the former by an indefinable line. No hard and fast line can be drawn to separate animal from plant, and none to separate plant from crystal. The force which is the cause of production and of change seems as if it were simply modified to suit the various structures which it builds. The material in all three kingdoms of nature is without doubt the same. One force —one matter—is foreshadowed here.

It will be advisable to look a little more closely at this material.

The most generally accepted hypothesis of the evolution of the solid earth on which we live begins with La Place's celebrated generalization of the condensation of tenuous material,—first to vapor; then to liquid; then to solid, at an intensely high temperature; and finally by cooling to the globe that we know.

Dr. T. Sterry Hunt (Chem. and Geol. Essays) has taken up the history where La Place leaves it, or at the stage where the in great part molten earth is covered by a thin shell of rock, like lava or basalt, upon which descend acid rains containing hydrochloric, sulphuric, and nitric acids, hitherto kept in suspension by the intensely high temperature. The crust on which these rains descend would necessarily be made of the lightest elements combined together; the heaviest would be found near the centre of the earth.

These lightest materials, which while in fusion floated on the rest like an ocean, would consist of silica and the alkalies and alkaline earths, with some of the rarer elements. On this subject a recently published memoir of Prof. F. W. Clarke, Chemist of the U. S. Geological Survey, is extremely interesting. Prof. Clarke has for the first time systematically investigated the composition of the crust of the earth for a depth of ten miles from the surface, by comparing a great number of analyses of the various rock strata of different parts of the world with each other.[3]

[3] Relative Abundance of Chemical Elements, by Frank Wigglesworth Clark, Philosophical Society of Washington Bulletin, Vol. XI., pp. 131–142.

From the mean of 880 analyses he finds that the solid crust constitutes 93 p. c.; the ocean 7 p. c.; and the air much less than 1 p. c. by weight (so that the latter is added as a slight correction applied to the ocean).

Taking these figures, he has calculated from the above 880 analyses, made in all parts of our own country and Europe and throughly combined and sifted, the following curious table of the frequency of the various elements. He adds that the fifty odd elements not included here can hardly aggregate 1 p. c. altogether.[4]

	P. C.
Oxygen	49.98
Silicon	25.30
Aluminum	7.26
Iron	5.08
Calcium	3.51
Magnesium	2.50
Sodium	2.28
Potassium	2.23
Hydrogen	0.94
Titanium	0.30
Carbon	0.21
Chlorine and Bromine	0.15
Phosphorus	0.09
Manganese	0.07
Sulphur	0.04
Barium	0.03
Nitrogen	0.02
Chromium	0.01
Total	100.00

The effect of acid rains upon this slag-like material can easily be predicted, and the prediction agrees with the facts as observed. Thus the deduction from La Place's hypothesis would lead to a soil and air composed as we observe them, and the growth of all

[4] See Chem. and Geol. Essays, pp. 35–47.

things would necessarily be by accretion from the elements which predominated in this soil and atmosphere. This is also what we observe.

Some reasons for believing that life is simply one manifestation of force acting upon matter has been alluded to, but there are many other reasons. The demonstration of the correlation and conservation of force, by Graham, Helmholtz, Meyer, Joule, Tyndall and others, in the early sixties marks an epoch in the science of physics. Since the date of this beautiful generalization it has been the practice to calculate all forms of force in terms of heat or heat-units; and many experiments have shown that these heat-units were expended in carrying on the various life processes, precisely as they are in raising water into steam, and cooling the steam again into water by converting part of its heat into the mechanical motion of the parts of a machine.

Regarding an animal as a machine, and its food as the fuel to drive this machine, an approximate calculation has been made of the directions in which the combustion (or assimilation) of the food is employed during the daily use of their organs by animals, and the calculation has been found to agree quite closely with observed facts. It may be safely predicated, therefore, that the force which builds up the plant or animal is calculable in so many heat-units expended to so much work of this kind performed; i. e., to build an inch of sugar cane, as much force is required as would be represented by the burning of a given quantity of coal or wood, and the conversion of the heat thereby obtained into mechanical motion, etc. But the production of these heat-units must depend upon the ease with which certain elements or groups of elements can be broken up and formed into other groups; for this change, called chemical change, always results in the development of heat or its equivalent work. Keeping this fact in view, it is not difficult to understand why the bodies of plants and animals, which require for their very existence that these changes should be continually going on, should be composed of groups of elements easily broken up and re-formed, and of elements, too, which are known as combustibles, or those which greedily seek out and combine with oxygen.

The present state of our planet is this: First, an ocean of atmosphere resting on the surface of the globe, in which exist myriads of living things, composed largely of carbon and hydrogen,—both elements that combine with oxygen, evolving an immense number of heat-units These elements, carbon and hydrogen, while combining together, do so in such a manner that the combinations are easily broken up in presence of the oxygen, for which they have a stronger affinity. "Oxygen is absorbed and carbonic acid evolved in germination, at the birth of the young plant, and in flowering when it arrives at an adult state. In both instances starch is oxidized and converted, first into dextrine, and then into sugar for the nutriment of the young embryo, stamens, and pistils, and these processes are accompanied by a development of heat.

"The respiration of the cotyledonary leaves of the embryo, and of the corrolline envelope of the stamens and pistils, is, in every respect, a true oxidation or combustion of the store of saccharine matter, accompanied by the evolution of carbonic acid.

"Respiration is absolutely essential to the growth of plants, as well as animals."[5] It is true that the leaves of plants under the influence of sunlight decompose the carbonic acid which results from the vital processes, and unite with the carbon in the air; a process not found in the animal economy: but it is nevertheless true that combustion of carbon to carbonic acid and hydrogen to water by the union of these two elements with the oxygen of the air proceeds equally with plant and animal, and is the source of that heat which constitute their vital force.

Thus far it has been indicated that the plant and animal are such structures as are adapted to exist on a soil of silica, alumina, lime, the alkalies, iron, and a few other materials, bathed in an atmosphere of oxygen (diluted with nitrogen), at temperatures between — 50° and 120° Fahrenheit, and exposed to the rays of the sun.

"The protoplasm which is the real body of the plant cell, to which the most important incidents of its life are attached, is a sticky, colorless, transparent mass, always containing water, and

[5] Harland Coultas: ' ant, an Illustration of the Organic Life of the Animal."

often drops of fat, crystals of carbonate of lime, and grains of starch. This protoplasm consists of inorganic and of organic matter, under which lattter term the albuminous materials and their products of modification or decomposition play an important part. The air-dried substance of the *Plasmodium septicum* contains, according to Dr. Rodewald, 29, 25 p. c. of ash, consisting of:

	P. C.
Lime,	64.34
Magnesia,	0.71
Potash,	1.42
Soda,	0.18
Oxide of iron,	0.13
Carbonic acid,	36.02
Phosphoric acid,	6.49
Sulphuric acid,	0.42
Chlorine,	0.21
	99.93

The ether extract of the protoplasm contains:

	p. c.
[6] Paracholesterin,	22.00
Fatty acids,	3.00

Leithicin, traces of glycerin, and resins.

Besides there are present hydro-carbons, albuminous matter, and other nitrogenous bodies, which are more products of decomposition of albumen.

"There are certainly disastase, fat emulsion-making ferments contained in it, besides plastin and albumen substance like fibrin, Myosin, Quenin, Sarkin, Xanthin, Carbonate of Ammonia, Butyric acid, and Coneisinic acid.[7]

All these substances are composed of carbon, hydrogen, oxygen and nitrogen, with small quantities of sulphur and phosphorus, etc.

[6] Paracholesterin is one of the isomeric alcohols of Cholesterin (Liebig's Annalen, Vol. 207, p. 229).

[7] Husemann, Pflanzenstoffe, 2d Ed., 1884.

A mean of two analyses of the albumen or stored food of the plant seed is :[8]

Carbon	53.21
Hydrogen	7.29
Oxygen	22.85
Nitrogen	15.78
Sulphur	.40
	99.43

The same elements enter into the composition of the protoplasm of animals, as may be seen from Robin's analysis of the amniotic fluid of a fecundated ovum, etc., etc. (Flint's Text Book of Physiology, p. 903).

In the main these elements of the protoplasm of both plants and animals may be regarded as hydro-carbons, or hydrogen and carbon with occasional nitrogen and oxygen, drawn from the soil and air into the plant, and from the plant into the animal, and expended by both as fuel, producing the motor known as vital force. It has been said that in the main constituent of this material were hydrogen and carbon, but it was not implied that these were the only constituents of this substance.

What we call "nature" acts in this as in so many other instances as a prudent speculator who will not entrust all his eggs to one basket. An analysis, however crudely conducted, will detect in the simplest food-stuff of plants, besides hydrogen and carbon, sulphur, phosphorus, chlorine, potassium, sodium,and calcium. More careful analysis of larger amounts of material will detect the presence of many other and rarer substances, iron, copper, iodine, etc. Still more delicate tests increase the number of chemical elements which are present, either as accessories, as "rare" or "very rare" concomitants.

It is not an unjustifiable generalization to say that the number of chemical elements contained in the "albumen" of a seed-sac or the amniotic fluid of a mammal increases with every increased

[8] See Dragendorff's Plant Analysis, p. 288, N. Y., Vail & Co., 1887.

effort to detect them, so that it is not at all unreasonable to conclude that practically the whole category of elements forming the superior part of the earth's crust, or floating as gases in the atmosphere, is represented in this material.[9]

Under the conditions of temperature, actinism (or the chemical effect of the sun's rays), barometric pressure, and constitution of the atmosphere and soil, the organic beings of our globe draw on their protoplasm for certain elements in excess of others, because under these conditions the decompositions and recompositions which take place are suited to maintaining life; but, should any or all of these conditions change; should the barometric pressure caused by the attraction of gravitation increase or diminish; should the proportion to each other of the constituents of the atmosphere suffer any marked variation; in any of these cases the present equilibrium would be disturbed; the oxidation and deoxidation of the materials now employed as the bases of organic structure would evolve and absorb too many or too few heat-units for the present system of life, and either this latter would change, giving rise to new animals and plants, or the materials which would be selected from the protoplasm for assimilation would be other than carbon and hydrogen, thus giving rise to different structures, composed of different materials, and behaving differently to heat and cold and chemical reagents.

In a paper on Animal Protoplasm, read before the Am. Phil. Soc., and printed in the AMERICAN NATURALIST in 1879, I considered the effect of changes of this kind on animals, pointing out that life being incomprehensible except as we could measure or weigh the phenomena which accompanied it, and these phenomena being such as would naturally occur among the substances by which we are surrounded, there was nothing to preclude the idea of living things colder than frozen mercury or hotter than molten platinum. This is true of the plant as well. As long as

[9] It would be apposite here to refer to Crooke's beautiful hypothesis of the evolution of the elements to show that each so-called element is probably only one physical manifestation of the same matter, made permanent by the peculiar conditions which surrounded it at its genesis, and that therefore in any mass of matter we have one or more forms of the single matter which constitutes all things. But this would lead us astray from the argument in hand.

force and matter exist, there is no reason to deny that they may produce the root and stem and leaves of the plant, of materials which will enter into the cycle of changes now effected at greatly higher or lower temperatures, thus preserving the rate and kind of change, while altering the materials which undergo it. This result would be a metasomatic evolution. On the other hand, the greater rapidity or slowness of these reactions might change the character of the organism, while the material remained unchanged, which would produce a metagenetic evolution. Or both substance and rate might alter, giving rise to an entirely different world, with different organisms and different processes, and as far from our present world as is the spiritual from the material.

To resume the case: 1. A careful study of the modes of growth in the three kingdoms of nature—mineral, plant, and animal—shows that there are strong analogies between them, the divergence being progressive in the order named, though many of the strongest characteristics, such as sensation, etc., of the highest or animal kingdom, are of such a kind that we are prevented from knowing their presence or absence in the other kingdoms.

2. The characteristics common to all three kingdoms are the presence of force; its action upon matter; and its renewal by the change of one form of matter to another, in the course of which energy is manifested.

3. In the crystal kingdom the restrictions on the existence and growth of the individual being least, and the variations of conditions and environment in which existence is possible, greatest, the individuals are more numerous and their composition more diverse, all of the known and unquestionably many as yet unknown elements uniting to form them.

4. As to the plant and animal kingdom the cycles of changes are based for the most part upon the disunion and separate combinations of carbon and hydrogen, because, at the existing temperature, pressure oxygen-atmosphere, and sunlight, these changes can be produced to the greatest advantage of existing kinds of living things and life forces.

5. With a much hotter or colder earth; an earth where the weights of bodies were much greater or much less they are now; an earth not surrounded by an ocean of oxygen gas; or an earth deprived of the chemical force of our sun; some changes would be made in the modes in which life is perpetuated now, to suit these changed conditions of the planet, *but it is extremely unlikely that life would be extinguished by them, unless the conditions changed too suddenly.*

6. The nature of these changes would be either: (a) to keep foreign matter flowing through the living body at about the rate it flows now, in which case the hydro-carbons would give place to some other group or groups of chemical elements to supply the framework of the plant or animals; or, (b) the rate of change of these groups of atoms being very much altered, the attributes of the living things of which they formed a part would be very much changed; or, (c) if both the elements themselves and the rapidity with which these resolved themselves into new combinations were changed, the diversity of the living things and of the world itself would be so different from what they are now that we have no means of forming the least conception of them.

7. But in no one of these cases is it likely that *life* would become extinct, though the present relations to each other of the three kingdoms of nature would cease to be.

ON THE CLASSIFICATION OF THE TESTUDINATA.

BY GEORGE BAUR.

BOULENGER, Döderlein, Zittel, and Lydekker have lately published more or less extensive works on the Testudinata. All these publications I have to discuss first before I shall undertake to give my own views on the natural arrangement of the group.

I begin with Boulenger. A general classification of the Testudinata was given by him in 1888 in the 23d volume of the 9th edition of the Encyclopædia Britannica, pp. 456–457.

The whole group was, after Dollo, divided into two sub-orders, I. *Athecæ*, II. *Testudinata.*

The Athecæ contained the single family "*Sphargidæ*," with the genera Dermochelys, Psephophorus, Protosphargis, Prototstega, Psephoderma?; the Testudinata all the other Tortoises, which were divided in Cryptodira, Pleurodira, and Trionychoidea.

In the year following this classification was adopted by Boulenger in his catalogue of Chelonians[1], but the name of the second sub-order was changed into *Thecophora.* The whole order was called *Chelonia.*

A few months later Döderlein[2] published a classification of Testudinata. He distinguishes four sub-orders: *Atheca, Trionychoidea, Cryptodira, Pleurodira.*

Nearly at the same time the first part of the Reptilia of Prof. Zittel's "Handbuch der Palæontologie"[3] appeared, containing the Testudinata.

Zittel accepted three sub-orders of the Testudinate; *Trionychia, Cryptodira, Pleurodira.* The Athecæ are not accepted, but considered a family of the Cryptodira.

[1] Boulenger, George Albert. Catalogue of the Chelonians, Rhynchocephalians and Crocodiles in the British Museum (Natural History), London, 1889, pp. 4–6.

[2] Elemente der Palæontologie, pp. 633–634.

[3] Zittel Karl G. Handbuch der Palæontologie. Vol. III., part 3. München und Leipzig, 1889, pp. 513–547.

Lydekker calles the whole order Chelonia, which he divides into two sub-orders, *Athecata* and *Testudinata.*

The Athecata correspond to the Athecæ; the Testudinata contain four sections: 1. *Amphichelydia;* 2. *Pleurodira;* 3. *Cryptodira;* 4. *Trionychoidea.* In the *Amphichelydia* are placed the Pleurosternidæ. "This section is formed for the reception of certain extinct Chelonians, mostly of Mesozoic age, which combine in a remarkable manner the characters of the two following sections [Cryptodira and Pleurodira], and may probably be regarded as the survivors of the earlier ancestral types from which those two sections took origin."

THE ORDINAL NAME FOR THE TORTOISES.

Boulenger and Lydekker use the name Chelonia; Zittel and Döderlein the name Testudinata. The name Chelonia has no right to stand, and must give place to that of *Testudinata,* as will be seen from the following table:

Boulenger, p. 4.—Order, *Chelonia.*

Cheloniens, Brongniart, Brit. Soc. Philos., II., 1800.
Testudinata, Oppel, Order Rep., 1811.

Baur.—*Testudinata,* Klein, 1751.

1751. *Testudinata,* Klein, Jac. Theod., Quadrupedum Dispositio brevisque Hist. Nat., 1751, p. 96.

1799. *Cheloniens,* Brongn, Mag. Encycl. ou Journ. des Sciences, des Lettres et des Arts, par A. L. Millin, T. VI., An. VII., 1799, pp. 184-201.

1802. *Testudines,* Treviranus, G. R., Biologie, Bd. I., p. 260, Göttingen, 1802.

1806. *Testudines,* Shaw, G., General Zool., Vol. III., Part 1., p. 5., London, 1802.

1806. *Chelonii,* Dumeril, A. M. C., Zool. Anal., Paris, 1806, p. 76.

[4] Lydekker R., in Henry Alleyne Nicholson and Richard Lydekker. A Manual of Palæontology, Vol. II., part III. Edinburgh and London, 1889, pp. 1082–1118. And Lydekker, Richard, Catalogue of the Fossil Reptilia and Amphibia in the British Museum (Natural History), Part III., containing the order Chelonia. London, 1889.

1822. *Chelonea*, Fleming, Philos. of Zool., Vol. II., p. 268, Edinburgh, 1822.

1825. *Fornicata*, Haworth, A. Tilloch, Phil. Mag., LXV., 1825, pp. 372-373.

1828. *Sterrichrotes*, Ritzen, F. F. A., Nova Acta Nat. Cur., 1828, Vol. XIV., Bonn, 1828.

1834. *Chelonia*, Carus, G., Lehrbuch der Vogl., Zool. Aufl. I., Theilp. 25, Leipzig, 1834.

The Athecæ.—I have shown in a paper published some time ago,[5] that the group Athecæ, or Athecata, as spelled by Lydekker, is an unnatural one, and that its members belong to the Pinnata, or sea-tortoises. I do not need to discuss this question fully again on this plate; I shall only give my principal reasons.

Protostega and Protosphargis, which are placed by Boulenger, Lydekker, Döderlein, among the Athecæ, are near the Cheloniidæ. In both true marginal bones (peripheralia) are developed. The skull of Protostega is like that of the Cheloniidæ; there is a free epipterygoid, and the descending processes of the parietals are present; also an ossified articular bone. Humerus and coracoid are in shape between those elements in Dermochelys and Cheloniidæ. It seems that Lydekker is inclined lately to accept my idea of the relationship of the Athecæ, for he says in the introduction to his Catalogue of Fossil Tortoises: "If the skull referred by this writer (Baur) to Protostega be rightly assigned, there will be evidence of a closer connection between the two groups (Cheloniidæ and Protostegidæ) than has hitherto been supposed. The skull from which I took these remarks is certainly rightly assigned," for it is the type of Protostega, and all the above points are mentioned by Prof. Cope[6] in his description, with figures, of Protostega; even Lydekker, who still sustains the Athecæ, will have to admit now that at least the Protostegidæ

[5] Baur, G. Die systematische Bemerkungen über die systematische Stellung von Dermochelys, Blainv. *Biol. Centraebl.*, Vol. IX., Nos. 5, 6. 1889, pp. 149-153; 180.191.

Nachtraegliche Bemerkungen über die esystematische stellung von Dermochelys Blainv., *Biol. Centraebl.* Vol. IX., Nos. 20, 21, pp. 617-619; see also my notes in *Zoöl. Anz.*, No. 238, 188, 1886; *Science*, Vol. XI., No. 268, 1888; *Zoöl. Anz.*, No. 285, 1888, and No. 298, 1889.

[6] Cope, E. D., The Vertebrata of the Cretaceous Formations of the West. Rept. U. S. Survey Territ., Vol. II., 1875.

are very near the Cheloniidæ, and belong certainly to the Pinnata. After it shall have been proved that in Protostega and Protosphargis an entoplastron is always absent, they will rank as a distinct family from the Cheloniidæ, to be placed between the latter and the Dermochelyidæ. I have shown now that Protostega and Protosphargis are true Pinnata; we have now to consider the remaining genera of the group: Dermochelys, Psephophorus, Eosphargis, and Psephoderma. I do not consider Psephoderma at all in this connection; it is, so far, impossible to determine the exact systematic position of this genus. Such dermal ossification as seen in Psephoderma may appear in any order of the Reptilia. I have shown that the absence of the descending processes of the parietals in the remaining three genera is an entirely secondary condition, that all Testudinata possessed originally an epipterygoid and the descending processes, and that in the Pinnata the tendency is present to abort these processes. I have shown that the character given by Boulenger to Dermochelys, that the lower border of the postfrontal joins the jugal and the squamosal, and is separated from the quadratojugal by the two latter bones, does not hold, for it is also found in specimens of Chelonia. But to convince everybody that Dermochelys and its fossil allies, Psephophorus and Eosphargis, cannot be separated from the Pinnata, I give the characters which are only found in the Pinnata, and in no other group of the Testudinata. These characters are:

1. The foramen palatinum, between palate and maxillary, is absent.

2. The articular faces between the sixth and seventh cervicals are plane.

3. The nuchol has a distinct process on the lower side for the articulation of the neuroid of the eighth cervical.

4. The small trochanters of the femur are united, and there is a fossa between these and the large trochanters. (This condition is also seen in the true land tortoises, Testudinidæ).

5. There is only one central line in the carpus; the intermedium reaches the first carpale, excluding the centrale from the radiale.

The characters, with the exception of No. 4, are typical for the Pinnata, but they are also typical for Dermochelys. *That the Dermo-*

chelyidæ represent a specialized branch of the Pinnata there cannot be any doubt whatever. The mosaik-like carapace and plastron of these forms is probably a secondary formation, which appeared after the dermal part of the ribs had disappeared entirely. The oldest Dermochelyidæ known are from the lower Eocene (Eosphargis). True Cheloniidæ are known already from the Cretaceous, and the intermediate Protostegidæ are from the same formation; *it is probable that the Protestegidæ have to be considered as the ancestor of the Dermochelyidæ.*

After it has been shown that the Athecæ are an unnatural group, and belong to the Pinnata, we have to consider the other divisions proposed. Boulenger, Lydekker, Döderlein, Zittel, all accept the groups Pleurodira, Cryptodira and Trionychia; these groups are certainly natural, as will be admitted by everybody; a new section was introduced by Lydekker under the name of Amphichelydia (*Quart. Jour. Geol. Soc.*, XLV., p. 518, 1889). "They are characterized by having a shell constructed on the plan of that of the Cryptodira and Pleurodira, in which mesoplastral bones and an intergular shield are developed. The pubis may articulate, without sutural union, with the xiphiplastral."

The skull and neck are unknown. The coracoid and humerus (when known) are of a Pleurodiran type (Lydekker, Cat., pp. 204, 205). This group is also natural, and corresponds to a sub-order to which I have given a different name in MSS., and the characters of which I can point out in full. The material on which these characters are based consists of nearly all parts of the skeleton, including skull and cervicals of *Compsemys plicatulus* Cope, the oldest American Tortoise, from the Jurassic of the Rocky Mountains. Most of the material was examined at the Peabody Museum, New Haven, Conn. Especially I have to state the interesting fact that *Compsemys* has a complete mesoplastron, and resembles very much Pleurosternum. This is another support for the view that the Camarasaurus beds correspond to the Purbeck and Oolite of England.

I give now the characters of the five sub-orders of Testudinata, which I adopt:

I. *Amphichelydia.*

Nasals free; a squamoso-parietal arch; descending processes of prefrontals joining vomer; stapes in an open groove of the quadrate; pterygoids narrow in the middle, without wing-like lateral expansions, separating quadrate and basisphenoid; epipterygoid well developed and free; dentary bones distinct. Cervical vertebræ with well-developed transverse processes, more in front of vertebra, with single articular faces, biconcave; dorsal vertebræ, sacral vertebræ, with well-developed ribs; ribs of sacral vertebræ connected with centrum and neuroid. Pelvis not anchylosed to the carapace and plastron. Epiplastra in contact with hyoplastra, entoplastron oval or rhomboidal; a complete series of peripheralia connected with the ribs.

II. *Pleurodira.*

Nasals free, or united with prefrontals; a squamoso-parietal arch present or absent; descending processes of prefrontals absent; stapes in a groove of quadrate generally closed on the outside; pterygoids broad, forming wing-like lateral expansions, not separating quadrate and basisphenoid; epipterygoid not free; dentary bones distinct and united. Cervical vertebræ with well-developed transverse processes generally in middle of vertebra, with single articular faces; sacral ribs rudimentary; sacral ribs connected with neuroids. Pelvis anchylosed to carapace and plastron. Epiplastra in contact with hyoplastra, entoplastron oval or rhomboidal; a complete series of peripheralia connected with the ribs.

III. *Cryptodira.*

No free nasals; a parieto-squamosal arch present or absent; descending process of prefrontals connected with vomer; stapes in an open grove, entirely covered by the quadrate behind; pterygoid narrow in the middle, without wing-like lateral expansions, separating quadrate and basisphenoid; epipterygoid free, or not free; dentary bones united. Cervical vertebræ with rudimentary transverse processes in front of vertebra; the posterior

cervicals with double articular faces; sacral ribs well developed, and connected with centrum and neuroids. Pelvis free from plastron and carapace. Epiplastra in contact with hyoplastra, entoplastron oval, rhomboidal or T-shaped; a more or less complete series of peripheralia more or less connected with the ribs.

IV. *Chilotæ* (Trionychia).

No free nasals; no parieto-squamosal arch; descending processes of prefrontals connected with vomer or not; stapes entirely surrounded by quadrate; pterygoids broad, without wing-like lateral expansions, separating quadrate and basisphenoid; epipterygoid free; dentary bones united. Cervical vertebræ with very rudimentary transverse processes in front of vertebra; the posterior cervicals with double articular faces; sacral ribs well developed, and connected with neuroids only. Pelvis free from plastron and carapace; epiplastra separated from hyoplastra by the V-shaped entoplastron; marginal bones absent, or forming an incomplete series, not connected with the ribs.

RECORD OF AMERICAN ZOOLOGY.

BY J. S. KINGSLEY.

(Continued from Vol. XXIV., page 454.)

IT is the intention to catalogue here in systematic order all papers relating to the Zoology of North America, including the West Indies, beginning with the year 1889. An asterisk indicates that the paper has not been seen by the recorder. Owing to the method of preparation it is impossible to collect in one issue all the papers relating to any group, but it is hoped that succeeding numbers will correct this. Authors are requested to send copies of their papers to J. S. Kingsley, Lincoln, Nebraska.

VERTEBRATA, GENERAL.

HEITZMANN, C.—The minute structure of the Cornea. I. The so-called cells of the Cornea. *Microscope*, IX., p. 354.

CAHALL, W. C.—The teeth as evidence of evolution. AM. NAT., XXIV., p. 224, 1890.

STEARNS, R. E. C.,—Instances of the effect of musical sounds on animals. AM. NAT., XXIV., p. 22, 123, 236.

MORRIS, CHARLES.—From Brute to Man. AM. NAT., XXIV., p. 341, 1890.

MCCLURE, C. F. W.—The primitive Segmentation of the Vertebrate Brain. *Zool. Anz.*, XII., p. 435, 1889.—See AM. NAT., XXIV., p. 187.

TUNICATA.

MORGAN, T. H.—Origin of the Test Cells of the Ascidians. J. H. U., Circ., VIII., p. 63, 1889.—Results agree well with those of Van Beneden and Julin.

FEWKES, J. W.—New Invertebrata from California. Bull. Essex Inst., XXI., p. 134, 1889 [1890].—Describes as new *Clavellinopsis* [n.g.] *rubra.*

CYCLOSTOMATA.

MEEK, SETH E.—Note on *Ammocœtes branchialis.* AM. NAT., XXI., p. 640, 1889.

TELEOSTS (including GANOIDS).

EIGENMANN, C. H.—On the Development of California Food Fishes. AM. NAT., XXIII., p. 107, 1889.

MATHER, FRED.—The Eggs of an Eel. *Am. Mo. Micros. Jour.*, X., p. 15, 1889.

PACKARD, A. S.—The cave fauna of North America. Mem. Nat. Acad., IV., 1889.—Mentions cave teleosts.

MORRISON, WILLARD R.—A review of the American species of Priacanthidæ. Proc. Phil. Acad., 1889, p. 159.—Species recognized are *Priacanthus catafula*, *P. cruentatus*, *P. bonariensis* (So. America) and *Pseudopriacanthus altus*.

KIRSCH, PH. H., AND FORDICE, MORTON, W.—A review of the American species of Sturgeons (Acipenseridæ), Proc. Phila. Acad., 1889, p. 245.—Recognizes *Scaphirhynchus platyrhynchus*, *Acipenser medirostris*, *A. sturio*, *A. rubicundus*, *A. brevirostrum*, *A. transmontanus*.

HENSHALL, J. A.—Some observations on Ohio Fishes. Jour. Cin. Socy. Nat. Hist., XII., p. 114.—General article.

KIRSH, PH. H.— A review of the European and American Uranoscopidæ or Star-Gazers. Proc. Phila. Acad., 1889, p. 258. —American species *Kathetostoma averruncus*, *Astroscopus anoplos*, *Upsilonphorus Y-græcum*, *U. guttatus*.

MEEK, S. E. AND BOLLMAN, C. H.—Note on *Elegatis bipinnulatus*. Proc. Phila. Acad., 1889, p. 42.—Description of Long Island specimen.

GARMAN, S. W.—A large Carp and its History. Proc. Bost. Soc., XXIV., p. 167, 1889.—*Cyprinus carpio*, from Ayer, Mass., weighing 16½ lbs.

GILBERT, C. H.—Fourth series of notes on the Fishes of Kansas. Bull. Washburn College, II., p. 38.—Enumeration of species.

BEARD, J.—On the early development of *Lepidosteus osseus*. Proc. Roy. Soc., XVI, p. 108, 1889.—Segmentation, origin of germ-layers, nervous system, peripheral sense organs, notochord, nephridia, giant cells in nervous system.

MCCORMICK, L. M.—List of Fishes of Lorain Co., Ohio. Jour. Cin. Soc. Nat. Hist., XII., p. 127, 1890.—Nominal list of 128 species.

MEEK, S. E.—The Native Fishes of Iowa. Bull. Lab. Nat. Hist. State Univ. Iowa, I., p. 161, 1889.—First part of a descriptive paper, including Catostomidæ, and enumerating 28 species.

JORDAN, D. S., AND FESLER, B.—Description of a new species of Orthopristis from the Galapagos Island. Proc. A. N. S., Phila., 1889, p. 36.—*O. lethopristis.*

IVES, J. E.—Mimicry of the environment in *Pterophryne histrio.* Proc. A. N. S., Phila., 1889, p. 344, 1890.—Comments on resemblances to Sargassum.

GILBERT, C. H.—Notes on the occurrence of *Gillichthys V-cauda* at San Diego, California. Proc. U. S. Nat. Mus., XII., p. 363, 1889 [1890].—*G. guaymasiæ*, doubtfully distinct; *Gobius townsendi*, young of *Gillichthys mirabilis.*

JORDAN, D. S., AND EVERMANN, B. W.—Description of the yellow-finned trout of Twin Lakes, Colorado. Proc. U. S. Nat. Mus., XII., p. 453, 1889 [1890].—*Salmo mykiss macdonaldi*, subsp. nov.

BATRACHIA.

MORGAN, T. H.—Notes on the fate of the *Amphibian blastopore.* J. H. U. Circ., VIII., p. 31, 1889.—Preliminary paper, see *infra.*

PETERS, J. E.—Another specimen of *Hyla andersonii.* AM. NAT., XXIII., p. 58, 1889.

HAY, O. P.—Notes on the habits of some Amblystomas. AM. NAT., XXIII., p. 602, 1889.

HAY, O. P.—Notes on the life history of *Chorophilus triseriatus.* AM. NAT., XXIII., p. 770, 1889.

COPE, E. D.—The Batrachia of North America. Bulletin U. S. Nat. Mus., No. 34, 1889. (See AM. NAT., XXIII, p. 793, 1889.)

RYDER, J. A.—Karyokinesis in larval Amblystoma. AM. NAT., XXIII., p. 827, 1889.

ABBOTT, C. C.—Frogs eating Snakes. AM. NAT., XXIV., p. 188, 1890.

ABBOTT, C. C.—Voice of *Hyla andersonii.* AM. NAT., XXIV., p. 189, 1890.

BORDEN, W. C.—Origin and development of the fat-cells of the Frog. *Microscope*, IX., p. 101, 1889.—Nothing new.

RYDER, J. A.—Heterocercy in Batrachia. Proc. Phila. Acad., 1889, p. 155.—In Amblystoma larva.

MORGAN, T. H.—On the Amphibian blastopore. Studies Biol. Lab. J. Hopkins Univ., IV., p. 355, 1890. Forms studied were *Bufo lustiginosus*, *Rana halecina*, *Amblystoma punctatum*.

HAY, O. P.—On the structure of the skull of the larva of Amphiuma. Proc. A. A. A. S., XXXVIII., p. 286, 1889.—Abstract.

BOULENGER, G. A.—Description of a new Batrachian of the Genus Eupemphix from Trinidad. *Ann. and Mag. N. H.*, III., p. 307, 1889.—*E. trinitatis*.

ROBERTS, H. L.—Frogs Eating Snakes. AM. NAT., XXIII., p. 74, 1889.

TOWNSEND, T.—Twelve species of Coleoptera taken from the stomachs of Toads in Michigan, with remarks on the food habits of Toads. Proc. Ent. Soc., Washington, I., p. 167, 1889.

COPE, E. D.—Report on the Batrachia and Reptiles collected [by the U. S. Fish Commission steamer Albatross] in 1887-'88. Proc. U. S. Nat. Mus., XII, p. 141, 1889 [1890].—*Bufo agua* from St. Lucia, W. I.

REPTILES.

NORTHROP, J. I.—*Coluber obsoletus* [near Newburg, N. Y.]. AM. NAT., XXIV., p. 82, 1890.

BAUR, G.—Osteologische Notizen über Reptilien. *Zool. Anzeiger*, XII., p. 40, 1889.

BAUR, G.—Revision meiner Mittheilungen in *Zoolsgischen Anzeiger*. *Zool. Anz.*, XII., 238.—Notes on osteology of various reptiles.

GARMAN, S. W.—On the evolution of the Rattlesnake. Proc. Bost. Socy., XXIV., p. 170, 1889.—Moulting of snakes and rattle-like structures in other snakes.

BAUR, G.—Die systematische Stellung von Dermochelys. *Biol. Centralbl.*, IX., 149, 180, 1889.—Dermochelys [Sphagris] is not a primitive form, but has descended from the "Thecaphora" and probably from the "Pinnata."

——. —Nachträgliche Bemerkungen über die systematische Stellung von Dermochelys, *l. c.*, p. 618, 1889.

HERRICK, C. L.—Notes on the Brain of the Alligator. *Jour. Cin. Soc. N. H.*, XII., p. 129, 1890.—Notes on anatomy and histology; illustrated by 9 plates.

COPE, E. D.—Tortoises sold in the markets of Philadelphia. AM. NAT., XXIV., p. 374, 1890.

SHUFELDT, R. W.—[No title] *Nature*, XLI., p. 181, 1889. —States existence of zygomatic arch in Heloderma.

BROWN, A. E.—Description of a new species of Eutænia. Proc. A. N. S., Phila., 1889, p. 421, 1890.—*E. nigrolateris* (Arizona).

STEJNEGER, L.—Descriptions of two new species of snakes from California. Proc. U. S. Nat. Mus., XII., p. 95, 1889 [1890]—*Lichanura orcutti*, *L. simplex*.

COPE, E. D.—Report on the Batrachians and Reptiles collected [by the U. S. Fish Commission steamer Albatross] in 1887-'88. Proc. U. S. Nat. Mus., XII., p. 141, 1889 [1890].—Three species from St. Lucia, W. I.

BIRDS.

STRODE, W. S.—The food of the Owls. AM. NAT., XXIII., p. 17, 1889.

RHOADES, S. N.—The mimetic origin and development of bird language. AM. NAT., XXIII., p. 91, 1889.

HARGITT, C. W.—Interesting cases of color variations. AM. NAT., XXIII., p. 449, 1889.

DANENHOUR, F. H.—Birds killed by electric lights at Girard College, Philadelphia. AM. NAT., XXIII., p. 823, 1889.

STRODE, W. S.—History of the Owl, continued. AM. NAT., XXIII., p. 833, 1889.

TIGHT, W. I.—*Hesperiphona vespertina* [at Granville, Ohio]. AM. NAT., XXIII., p. 82, 1889.

BAKER, F. C.—Notes on the food of Birds. Proc. Phila. Acad. 1889, p. 266.

HENDRICKSON, W. F.—The Chestnut-colored and Lapland Longspurs on Long Island, N. Y. *Auk*, VI., 190, 1889.

DAVISON, S. L.—Breeding of *Habia ludovicianus* in Niagara Co., N. Y. *Auk*, VI., p. 191, 1889,

HASBROUCK, E. M.—Restoration of an Abdubonian form of *Geothlypis trichas* to the American avifauna. *Auk*, VI., p. 167, 1889.

TORREY, B.—Bicknell's Thrush breeding in Vermont. *Auk*, VI., p. 617, 1889.

SENNETT, GEO. B.—Clapper Rails of the United States and West Indies compared with *Rallus longirostris* of South America. *Auk*, VI., 166, 1889.

RICHMOND, C. W.—Another saw-whet owl in the District of Columbia. *Auk*, VI., 189.—*Nyctala acadica.*

BOND, F.—*Myiadestes townsendi* apparently wintering in Wyoming. *Auk*, VI., 193, 1889.

TREAT, W. E.—A fishing screech owl. *Auk*, VI., 189, 1889.

*FEILDEN, H. W.—On the breeding of *Puffinus auduboni* in the island of Barbadoes.—*Ibis*, p. 60, 1889.

PRINCE, W. C.—The northern phalarope in the Franconia Mts., N. H. *Auk*, VI., p. 68, 1889,

ELLIOTT, H. W.—The cow-bird as a fly-destroyer. *Auk*, VI., p. 72, 1889.

EVANS, EVAN M.—*Calamospiza melanocorys* on Long Island, N. Y. *Auk*, VI., p. 192, 1889.

PALMER, WM.—Occurrence of Traill's fly-catcher near Washington. *Auk*, VI., p. 71, 1889.

SENNETT, G. B.—First description of the egg of *Glaucidium phalænoides*. *Auk*, VI., p. 70, 1889.

SHUFELDT, R. W.—Notes upon the sudden appearance in numbers of the Evening Grosbeak at Fort Wingate, New Mexico. *Auk*, VI., p. 72, 1889.

STEJNEGER, LEONHARD.—The proper name for the genus *Melanpitta*. *Auk*, VI., p. 79, 2889.—*Melopitta.*

SENNETT, G. B.—*Troglodytes ædon*, house wren, breeding in a sandbank. *Auk*, VI., p. 76, 1889.

GREEN, M. M.—Baird's sandpiper in Central New York. *Auk*, VI., p. 68, 1889.

SHUFELDT, R. W.—Notes on Brewster's and the blue-footed gannets. *Auk*, VI., p. 68, 1889.

Check List of North American Birds, according to the Canons of Nomenclature of the American Ornithologists' Union. Abridged edition, revised, pp. 71. Washington, 1889.

Supplement to the Code of Nomenclature and Check List of North American Birds, adopted by the American Ornithologists' Union.; pp. 74, New York, 1889.

FAXON, WALTER.—On the summer birds of Berkshire County, Mass. *Auk*, VI., p. 39-99, 1889.

CORY, C. B.—A list of the Birds collected by Mr. C. J. Maynard in the islands of Little Cayman and Cayman Brac. *Auk*, VI., p. 30, 1889.

ALLEN, J. A.—Note on the first Plumage of *Colinus ridgwayi*. *Auk*, VI.. 189, 1889.

BROWN, J. C.—Unusual nesting site of *Dendræca virens*. *Auk*, VI., 74, 1889.

——Early appearance of *Empidonax minimus* at Portland, Maine. *Auk*, VI., p. 71, 1889.

BROWN, N. C.—Notes on *Ægialitis meloda circumcincta*. *Auk*, VI., 70, 1889.

——Remarkable flight of Killdeer (*Ægialitis vocifera*) near Portland, Maine. *Auk*, VI., p. 69, 1889.

ALLEN, F. C.—Summer birds at Bridgewater and Moltonboro, N. H. *Auk*, VI., p. 75, 1889.

DOWNS, ANDREW.—Birds of Nova Scotia. Trans. Nova Scotia Inst., VII., p. 142, 1889.

PIERS, H.—Editor of "Birds of Nova Scotia" by Andrew Downs. *Supra*.

DUTCHER, W.—Bird notes from Long Island, N. Y. *Auk*, VI.. p. 131, 1889.

DUTCHER, B. H.—Bird notes from Little Gull Island, Suffolk Co., N. Y. *Auk*, VI., p. 124, 1889.

EVERMANN, B. W.—Birds of Carroll Co., Indiana. *Auk*, VI., p. 21, 1889 (Cont'd from *Auk*, V., p. 351, 1888).

——The Wood Ibis in Indiana. *Auk*, VI., p. 186, 1889.

LAWRENCE, GEO. N.—Remarks upon abnormal coloring of plumage observed in several species of birds. *Auk*, VI., p. 46, 1889.

——An account of the former abundance of some species of birds on New York Island at the time of their migration to the South. *Auk*, VI., 201, 1889.

——A new name for the species of Sporophila from Texas, generally known as *S. moreleti*. *Auk*, VI., p. 53, 1889.—*S. m. sharpei*.

——An account of the breeding habits of *Puffinus audubonii* in the island of Grenada, West Indies, with a note on *Zenaida rubripes*. *Auk*, VI., p. 19, 1889.

LUCAS, F. A.—Costal variations in birds. *Auk*, VI., 195, 1889.

BISHOP, LOUIS B.—Notes on the birds of the Magdalen Islands. *Auk*, VI., 144, 1889.—66 species.

——*Helminthophaga pinus, H. chrysoptera, H. leucobronchialis* and *H. lawrencei* in Connecticut, in the spring of 1888. *Auk*, VI., 192, 1889.

BRITTAIN, JOHN and COX, PHILIP, JR.—Notes on the summer birds of the Restigouche Valley, New Brunswick. *Auk*, VI., p. 116, 1889.

GOSS, N. S.—Additions to the catalogue of the Birds of Kansas, with notes in regard to their habits. *Auk*, VI., p. 122, 1889.

JEFFRIES, W. A. and J. A.—Notes on Western North Carolina Birds. *Auk*, VI., p. 119, 1889.

STONE, WITMER.—Graphic representation of Bird migration. *Auk*, VI., p. 139, 1889.

ROBINSON, WIRT.—Some rare Virginia birds. *Auk*, VI., p. 194, 1889.

SCOTT, W. E. D.—A summary of observations on the birds of the Gulf Coast of Florida. *Auk*, VI., pp. 13, 152. (Cont. from *Auk*, V., p. 379, 1888.)

——Records of rare birds at Key West, Florida, and vicinity, with a note on the capture of a dove new to North America. *Auk*, VI., p. 160.—*Geotrygon*.

SHUFELDT, R. W.—Contributions to the comparative osteology of the families of North American Passeres. *Jour. Morph.*, III., p.

82, 1889.—Classification upon osteology, results in placing the raven at the head of the oscine series.

——Notes on the anatomy of *Speotyto cunicularia hypogæa.* l. c. p. 116, 1889.—Visceral and muscular structures.

——Contributions to the comparative osteology of Arctic and sub-Arctic water Birds. *Jour. Anat. and Phys.*, XXIV., pp. 89, 169, 1889–90.—Osteology of puffins, loons, grebes.

Torrey, Bradford.—The booming of the Bittern. *Auk*, VI., p. 1, 1889.

Mason, E. C.—The Turkey-Buzzard in Massachusetts. *Auk*, VI., p. 70, 1889.

Bendire, Ch. E.—A peculiar nest of *Cinclus mexicanus*. *Auk*, VI., p. 75.

——Notes on the habits, nests and eggs of *Dendragapus obscurus fuliginosus*. *Auk*, VI., p. 32, 1889.

——*Sphyrapicus ruber* breeding in coniferous trees. l. c.—p. 71, 1889.

Lucas, Fred.—The main divisions of the Swifts. *Auk*. VI., p. 8, 1889.

Bendire, Ch. E.—Description of the supposed nest and eggs of *Zonotrichia querula*, Harris's sparrow. *Auk*, VI., 150, 1889.

——Notes on the general habits, nests and eggs of the genus Passerella. *Auk*, VI., p. 107, 1889.

Hardy, Manley. Additional notes on the Bittern. *Auk*, VI., p. 187, 1889.

Brewster, Wm.—Descriptions of supposed new Birds from western North America and Mexico. *Auk*, VI., 85.

——Occurrence of the western Sandpiper (*Ereunetes occidentalis*) in numbers on the coast of Massachusetts. *Auk*, VI., p. 69, 1889.

——Second occurrence of the Prairie horned lark in Eastern Massachusetts. *Auk*. VI., p. 71, 1889.

——The present status of Forster's teru as a bird of New England. *Auk*, VI., p. 66, 1889.

Peck, J, I.—Abstract of observations on the variation of the caudal nerves in the Pigeon. J. H. U. Circ., VIII., p. 63, 1889. —Preliminary account of next.

PECK, J. I.—Variation of the spinal nerves in the caudal region of the domestic Pigeon. *Jour. Morphol.*, III., p. 128, 1889.—Finds that the nerves vary in correlation with the parts.

RIDGWAY, R.—A review of the genus Xiphocolaptes of Lesson. Proc. U. S. Nat. Mus., XII., p. 1, 1889 [1890].—A study of the collections of Washington, New York, Boston and Cambridge. The forms within the limits of this record are *X. sclateri*, nov. (Mexico), *emigrans* (Guatemala), *costaricensis*.

RIDGWAY, R.—A review of the genus Sclerurus of Swainson. Proc. U. S. Nat. Mus., XII., p. 21, 1889 [1890].—Forms within the limit of this record are *S. albogularis* (Tobago), *canigularis* (Costa Rica), *mexicanus* (Mexico, South), *guatemalensis* (Guatemala to Panama).

RIDGWAY, R.—Birds collected [by the U. S. Fish Commission Steamer *Albatross*] on the Island of St. Lucia, West Indies [etc.] in 1887-'88. Proc. U. S. Nat. Mus., XII., p. 129, 1889 [1890]. —Fifteen species enumerated from St. Lucia.

MAMMALS.

MERRIAM, C. HART.—A correction: *Arvicola* (*Chilotus*) *pallidus*. AM. NAT., XXIII., p. 60, 1889.

RYDER, J. A.—The quadrate placenta of *Sciurus hudsonius*. AM. NAT., XXIII., p. 291, 1889.

AULD, R. C.—Some cases of solid-hoofed hogs and two-toed horses. AM. NAT., XXIII., p. 447, 1889.

HARGITT, C. W.—Interesting cases of color variation. AM. NAT., XXIII., p. 449.

DAVIS, WM. T.—The song of the singing mouse. AM. NAT., XXIII., p. 481, 1889.

GREENMAN, M. J.—Placentation of the Cat. AM. NAT., XXIII., p. 645, 1889.

AULD, R. C.—The segregations of polled races [of cattle] in America. AM. NAT., XXIII., p. 677, 1889.

SPITZKA, E. C.—Remarks on the brain of the seals. AM. NAT., XXIV., p. 115, 1890.

COLLETT, JOHN.—Bats in Wyandotte Cave. AM. NAT., XXIV., p. 189, 1890.

TUCKERMAN, FRED.—On the gustatory organs of *Erethizon dorsatus*. *Am. Mo. Micros. Jour.*, X., p. 181.

TAYLOR, W. E.—Color variations of Nebraska flying squirrels. Proc. A. A. A. S., XXXVIII., p. 287, 1889.

TUCKERMAN, FRED,—On the gustatory organs of *Sciurus carolinensis*. *Microscope*, IX., p. 193, plate.

BAKER, F. C.—Remarks upon the round-tailed muskrat, *Neofiber alleni*. True., Proc. Phila. Acad., 1889, p. 271.—Notes on habits and measurements.

SHUFELDT, R. W.—Observations on the development of the skull in *Neotoma fuscipes*. Proc. Phila. Acad., 1889, p. 14, Pls. 1 and 2.

TUCKERMAN, FRED.—On the gustatory organs of *Arctomys monax*. *Anat. Anz.*, IV., 334, 1889.

*LANGKAVEL, B.—*Nordamerikanische Wölfe* [*Canis latrans* and *C. occidentalis*]. *Zool. Garten*, XXIX., p. 364, 1889.

TUCKERMAN, FRED.—Gustatory organs of *Vulpes vulgaris*. *Jour. Anat. and Physiol.*, XXIII., p. 201, 1889.

STOWELL, T. B.—The muscles of the soft palate in the domestic cat. Proc. A. A. A. S., XXXVIII., p. 287, 1889.

PAYNE, F. F.—The effect of whistling on seals. AM. NAT., XXIV., p. 382, 1890.

DUGÈS, A.—La voix des chiens au Mexique. Bull. Soc. Zool. France, XIV., p. 69.

*ZIPPERLEIN, A.—Ein Lamantin, *Manatus americanus*. *Zool. Garten*, XXX., p. 25.

COPE, E. D.—The mechanical origin of the hard parts of the Mammalia. AM. NAT., XXIII., 71, 1889.

SCLATER, P. L.—African monkeys in the West Indies. *Nature*, XLI., p. 368, 1890. *Cercopithecus callitrichus* in St. Kitts.

COPE, E. D.—The mechanical causes of the development of the hard parts of the Mammalia. *Jour. Morphol.*, III., p. 137, 1889.—Extended paper with numerous illustrations.

TUCKERMAN, F.—Further observations on the development of the taste organs in man. *Jour. Anat. and Physiol.*, XXIV., p. 130, 1889.—Descriptions in embryos of 10th and 14th weeks.

——Gustatory organs of *Procyon lotor*, l.c., p. 156, 1 pl., 1890.

THOMPSON, E. E.—Critical note on Mr. J. B. Tyrrell's paper, entitled "Catalogue of the Mammalia of Canada exclusive of the Cetacea." Proc. Canada Inst., VII., p. 178, 1889.—Criticism of method of construction.

ALLEN, H.—On the taxonomic values of the wing membranes and of the terminal phalanges of the digits in the Cheiroptera. Proc. A. N. S., Phila., 1889, p. 313, 1890.—Shows that course of nerves in wing membrane can be used in classification.

HORNADAY, W. T.—The extermination of the American bison. Rep. U. S. Nat. Mus., 1886-'87, p. 369-548, 22 pls., 1889.—An exhaustive monograph upon the approaching extinction of *Bison americanus*.

EDITORIAL.

EDITORS, E. D. COPE AND J. S. KINGSLEY.

SENATOR EDMUNDS has introduced into the U. S. Senate a bill appropriating $500,000 for the endowment of a National University to be located in the city of Washington. It was referred to a committee. This is the outcome of a project which has been long entertained by some of the scientific officials attached to the departments of the government. A good deal may be said both for and contra this proposition. There is reason to doubt, in the first place, whether it is consistent with the character of our government to establish any central institution of this kind. Popular education has been one of the functions especially relegated to the state governments, and although the central government might well retain the power of compelling the former to attend to this important duty, so as not to imperil the welfare of the entire country, it can scarcely assume to create any system or institution of its own. But of course it is competent to establish and sustain such a university in and for the District of Columbia.

At one time the plan was to create the various scientific experts in the employ of the central government professors in the university. We hope that this feature is not embraced in the present bill. The gentlemen in question do not hold office at

present during good behavior, but only during the pleasure of the appointing powers. Changes have been and will be frequently made, and these are not always improvements when considered from the standpoint of merit and competency. Then there is that poison of the official atmosphere of the capital called "departmental courtesy" or "comity." According to this unwritten law, no subordinate of one department, commission or bureau, may indulge in criticism of the acts of any other similar organization without risk of losing his head; and few appointments of persons known to indulge in such criticism, or to entertain opinions unfavorable to the abilities or accomplishments of persons in high positions, are made. This so-called comity is observed between departments, etc., in no way dependent on each other, and in quarters where independence should be expected and even encouraged. The effect of such a state of affairs on the efficiency of expert employees can be easily understood. Incompetency, which should call forth criticism, is shielded, and those who would protect the country from its consequences are muzzled, so far as the government employees and their numerous followers are concerned. It is a lamentable fact that good and otherwise independent men are affected by this false and injurious sentiment after a short residence in the official atmosphere of Washington. The effect on the expert service is necessarily to depreciate it. The inferior men go free, and, sustained by their colleagues, are thus enabled to impose themselves on legislators who are not generally familiar with specialties in science. Thus it has happened that our government and people have been sometimes made ridiculous in the eyes of the learned world..

Under such circumstances the employment of Government servants in responsible positions in a "National University" would prove disastrous. The best men would be sooner or later rotated out of office and inferior men would take their places. The institution would become a by-word among the universities of the country, and nothing would be gained, while much would be lost.

On the whole, the proposition embraced in Senator Edmunds's bill does not impress us favorably.

—In a late number of *Science*, Professor J P. Lesley criticises our editorial of May on the coming meeting of the International

Congress of Geologists, and makes a number of statements that require notice. He desires to assume the responsibility of the proposition to transfer the meeting of the Congress from Philadelphia to Washington, stating with truth that it was he who introduced the proposition. He also states that in his opinion the meeting would be a failure if held in Philadelphia, and further that Major Powell, director of the U. S. Geological Survey, does not desire the Congress to be held in Washington. His conclusion is that the meeting had better not be held in America at all, but in Europe.

We did not refer to the fact that Prof. Lesley introduced the resolution above mentioned, for the reason that we desired to draw a veil over Prof. Lesley's connection with this matter, for obvious reasons. Now, however, that this gentleman has preceded us in describing his position, we feel no further delicacy in referring to it. Professor Lesley introduced the resolution to change the place of meeting in spite of the opposing representations of the other members of the Philadelphia committee present, —an opposition which has been since emphasized by the issue of a circular protest signed by Leidy, Hunt, Frazer, and Cope, to to which has been added, at his own request, the name of Senor Villanova, the Spanish member of the Bureau. The fact that Professor Lesley's colleagues are opposed to him in his views as to the holding of the Congress in Philadelphia should effectually silence his objections; for these are, we violate no confidence in saying, of a purely personal and most trivial character. That such motives should be permitted to disturb for a moment the Bureau of the International Congress is not to be thought of, although Professor Lesley's disloyalty to Philadelphia and to America may interfere with his usefulness in connection with the Congress when it meets there.

Professor Lesley states that Major Powell does not desire the meeting to be held in Washington. We are glad of it. We hope that it will not be held there, as good reasons for making a change at this late day are wanting. We will, however, observe that Professor Lesley's motion was not carried until one of Major Powell's had been adopted, viz.: that the Congress be not held in Philadelphia. The succeeding motions were mostly made

by Major Powell, and were adopted by the votes of the members and beneficiaries of his survey, while opposing resolutions were voted down by the same persons. It is stated that after the result was reached Major Powell said that he did not desire the meeting of the Congress in Washington. This is quite probable. It is an old political method to profess to desire one thing while in the act of doing another, and persons who have had relations with the present head of the Geological Survey know that he is a thorough master of this kind of diplomacy. Professor Lesley, however, appears to have been taken in by it. We suspect that the Bureau of the Congress will not be taken in, and that they will not be seriously incommoded by these exhibitions which mean nothing but personal idiosyncrasy.

—The Zoological Congress of Paris of 1889 has formulated a series of rules for the guidance of zoologists in the adoption and use of correct nomenclature. These reaffirm those proposed by the British Association for the Advancement of Science of a half century ago, and those adopted by the American Association at two different periods since that date. They insist, among other things, on the necessity of the presentation of a distinct diagnosis with a new name, in order to secure it recognition. This reaffirmation of the principal bulwark of honest nomenclature should serve as a hint to the American Ornithologists' Union to revise their somewhat ambiguous utterances on this subject; which savor more of the antiquarian than of the scientist.

—The Zoological Society of Philadelphia has recently added some rare animals to its collection. The wolverine has been very seldom seen in confinement, and the possession of two specimens is a piece of good fortune on which the Society and superintendent are to be congratulated. The greatest novelties known have been in the department of reptiles, where a number of rare species from Florida and Arizona have been exhibited for the first time. Two new species have been received, and have been described by Superintendent Brown. They are the *Eutænia nigrilateralis*, from Arizona, and a new genus of Calamarian snakes from Florida. The latter is the most noteworthy addition which has been made to North American herpetology for several years.

RECENT BOOKS AND PAMPHLETS.

AYERS, H.—The Morphology of the Carotids. *Bull. M. C. Z.*, XVII., 1889. From the author.

BEDDARD, F.—Anatomy of Accipitres.—Anatomy of the American Tapir.—Oligochætous Fauna of New Zealand. Extracts Proc. Zool. Soc., London, 1889.—Alimentary Canal of the Tinamou. Extract *Ibis*, 1890.—Possible Origin of Malpighian Tubules in Arthropoda. Extract *Ann. and Mag. Nat. Hist.*, 1889. All from author.

BOAS, J. E. V.—Kleinere carcinologische Mittheilungen. Extract *Zool. Jahrbuch*, 1889. From the author.

BRUNER, L.—Report of the Entomologist. Extract Nebraska State Board of Agriculture for 1888. From the author.

COMSTOCK, J. H.—On a Saw-fly Borer in Wheat. *Bulletin Cornell Exp. Station*, 1889. From the author.

CRAGIN, F. W.—Contributions to the Palæontology of the Plains. Extract *Bulletin Washburn College*, 1889. From the author.

DYBOWSKI, B.—Studien über die Säugethierzähne. Extract *Verh. k. k. Zool. Bot. Gesell.* Wien, 1889. From the author.

FEWKES, J. W.—On a Method of Defense among Certain Medusæ. Extract Proc. Bost. Soc. Nat Hist., 1889. From the author.

BONNIER, J.—Amphipodes du Boulonnais. Extract *Bull. Scient. France*, 1889. From the author.

HEATHCOTE, F. G.—Anatomy of Polyxenus. Extrait *Q. J. M. S.*, 1889. From the author.

LINTON, EDW.—Notes on Cestoid Entozoa of Marine Fishes Extract *Am. Jour. Sci.*, 1889.—Entozoa of Marine Fishes. Extract Report U. S. Fish Com. for 1886. 1889. From the author.

MERRIAM, C. H.—Revision of the North American Pocket Mice.—Description of fourteen new species and one new genus of North American mammals. Extract North American Fauna. From the author.

RYDER, J. A.—The Phylogeny of the Sweat Glands.—Proofs of the Effects of Habitual Use in the Modification of Animal Organisms. Extract Proc. Am. Philos. Socy., 1889. From the author.

SCUDDER, S. H.—Classified list of food plants of American Butterflies.—Work of a decade upon Fossil Insects. Extract *Psyche*, 1889. From the author.

STOWELL, S. B.—Soft Palate of the Cat. Extract Proc. Am. Socy. Microscopists. From the author.

WATASE, S.—Morphology of the Compound Eye of Arthropod. Studies J. H. Univ., 1889. From the author.

WHEELER, W. M.—Two New Species of Cecidomyid Flies.—Two Cases of Insect Mimicry. Extract Proc. Wisc. Nat. Hist. Socy., 1889. From the author.

Dept. of Agriculture. Dept. of Chemistry, Bulletins 13, 20, 21, 22, 23. Experiment Station Record, Vol. I., No. 1. Exp. Station Bulletin, No. 4. From the Dept.

POTEAT, W. L.—A tube-building spider. Extract Jour. Elisha Mitchell Socy., 1889. From the author.

FORBES, S. A.—History and Status of Public School Science Work in Illinois. From the author.

SHUFELDT, R. W.—Remarks upon Extinct Mammals of United States. Reprint *American Field*, 1889. From the author.

WILDER, B. G.—Brain-weight, etc. Extract Reference Handbook Med. Science. From the author.

——— ———.—Relation of the Thalamus to the Paracœle. Extract *Journal Nervous and Mental Diseases*, 1889. From the author.

CARRIERE, J.—Zur Embryonalentwicklung der Mauerbiene (*Chalicododerma muraria*). Extract *Zool. Anz.*, XIII., 1890. From the author.

PILLING, J. C.—Bibliography of the Iroquoian Languages, Washington, 1889. From the Bureau of Ethnology.

——— ———.—Bibliography of the Muskhogean Languages. Washington, 1889. From the Bureau of Ethnology.

THOMAS, C.—The Problem of the Ohio Mounds. Washington, 1889. From the Bureau of Ethnology.

——— ———.—The circular, square and octagonal Earthworks of Ohio. Washington, 1889. From the Bureau of Ethnology.

MORGAN, T. H. Preliminary Note on the Embryology of Pycnogonids. J. H. U. Circ., 1890. From the author.

HOLMES, W. H. Textile Fabrics of Ancient Peru. Washington, 1889. From the Bureau of Ethnology.

GARMAN, H. Animals of the Waters of the Mississippi bottoms near Quincy, Ill. 1889. From Ill. State Lab. Nat. Hist.

MORGAN, T. H. On the Amphibian blastopore. Extract J. H. U. Studies Biol. Lab., IV., 1890. From the author.

SHUFELDT, R. W. Progress in Avian Anatomy. Extract *Jour. Comp. Med.*, 1890. Contributions to the Comparative Osteology of Arctic and Sub-Arctic Water Birds. Extract *Jour. Anat. and Phys.*, XXIV., 1889. From the author.

STEDMAN, JOHN MOORE. Researches on the Anatomy of *Aphistomum fabaceum* Diesing. Ext. Proc. Amer. Socy. Micros., XI., 1889.

———.—On the development of and a supposed new method of reproduction in Actinosphærium. Extract *The Microscope*, VIII. From the author.

WATASE, S.—Karyokinesis and Cleavage of the Ovum. Ext. J. H. U. Circ. IX., 1890. From the author.

FERNALD, H. T.—Studies on Thysanure Anatomy. J. H. U. Circ., 1890. From the author.

HERRICK, C. L. Notes upon the brain of the Alligator. Extract Jour. Cin. Socy. Nat. Hist., 1890. From the author.

RECENT LITERATURE.

Lapparent's Course in Mineralogy,[1] second edition, is a valuable book to any one interested in the more theoretical method of discussing crystallography and mineralogy. By far the most interesting portions of the volume are those relating to crystallography and physical mineralogy. The first part is concerned with a discussion of the general principles of symmetry, and the development of the different crystallographic systems. The method of treatment is philosophical and clear. More emphasis is placed on the general laws governing crystallization than is usually the case in text-books of this class. The clear explanations of the relations of the different systems to each other, and of the development of these in accordance with the general law of symmetry, are, however, rendered somewhat obscure to the non-French reader by the use throughout the volume of the Lévy system of crystallographic notation, without the least reference in the text to the corresponding Naumann or Miller notation. That portion of the book devoted to the physical properties of minerals treats — 1, of the general laws governing the propagation of light; 2, those governing polarization and interference of light; 3, the mechanical, electric and thermal properties of crystals; 4, the grouping of crystals; 5, isomorphism and polymorphism; and 6, crystallogenesis. This second portion of the treatise is no less philosophical than is the first part. Many of the obscure points in physical mineralogy, merely touched upon or left unnoticed in most text-books, are treated here with as much fulness as could reasonably be expected. The importance attached by the author to the subject of mineralogical physics may be deduced from the fact that 140 of the 647 pages of the volume are occupied in its treatment, while 200 contain the morphological discussion, leaving 260 to include the description of mineral species, etc. The third portion of the work, that treating of the mineral species, is by no means as satisfactory as the first two parts. The description of the species are not sufficiently full, nor are the figures of crystals as good as they might be. On the other hand, the axial ratio of each species has been recalculated, and the results of recent measurements have been incorporated in the text. Quite a good deal of space is also devoted to the microscopic characters of many of the species, so

[1] A. de Lapparent; Cours de Mineralogie, 2d ed. 598 ills. 1 pl. 647 pp. Paris, 1890.

that, on the whole, the "Cours de Mineralogie" is better adapted to the wants of the well-rounded mineralogist than any other single book published. A table showing the relations between the crystallographic symbols of Lévy, Miller, Naumann and Dana, and an index of thirty-five pages, complete the volume. Before concluding this notice, it should be mentioned that the author finds no existing method of mineral classification satisfactory to himself. He divides the minerals into four groups, as follows: 1, the elements of rocks; 2, the elements of mineral deposits; 3, metallic minerals, and 4, combustible minerals; and uses this classification as the basis of the *systematic* portion of his book.

Lévy's Structures et Classification des Roches Eruptives.—Lévy's small volume[2] on the classification and structure of rocks is so entirely argumentative that no satisfactory analysis of it can be given in these pages. It is directed against Professor Rosenbusch's classification. Many instances are cited to show that the principles of this latter classification, when pushed to their legitimate consequences, must lead to the grouping together of rocks that have little similarity to each other, while, on the other hand, many that are evidently closely connected genetically must be widely separated in different groups. Lévy calls for a purely petrographical classification of rocks, independent of geological considerations. The author's cause would have appeared much stronger had his arguments been less sprinkled with claims to priority over Rosenbusch in the proposal of terms descriptive of rock structure. The book merits close study as an appeal to petrographers to cut loose from theoretical considerations, and to make their classifications, for the present at least, expressions of observed facts.

Thomas's Ohio Mounds.[3]—In these two papers Dr. Thomas continues to maintain his thesis, already noted in our pages, that the earthworks of Ohio were built by the ancestors of the Red Indians of historic time. In the second of the two papers, the Cherokees are shown to have been mound-builders since the advent of the whites; and our author tries to trace them northward, connecting them with the monuments in West Virginia (near Charleston), and also with the traditional Tallegwi. To this end the Walum olam is invoked to show

[2] M. Levy; Structures et Classification des Roches Eruptives. 95 pp. Paris, 1889.

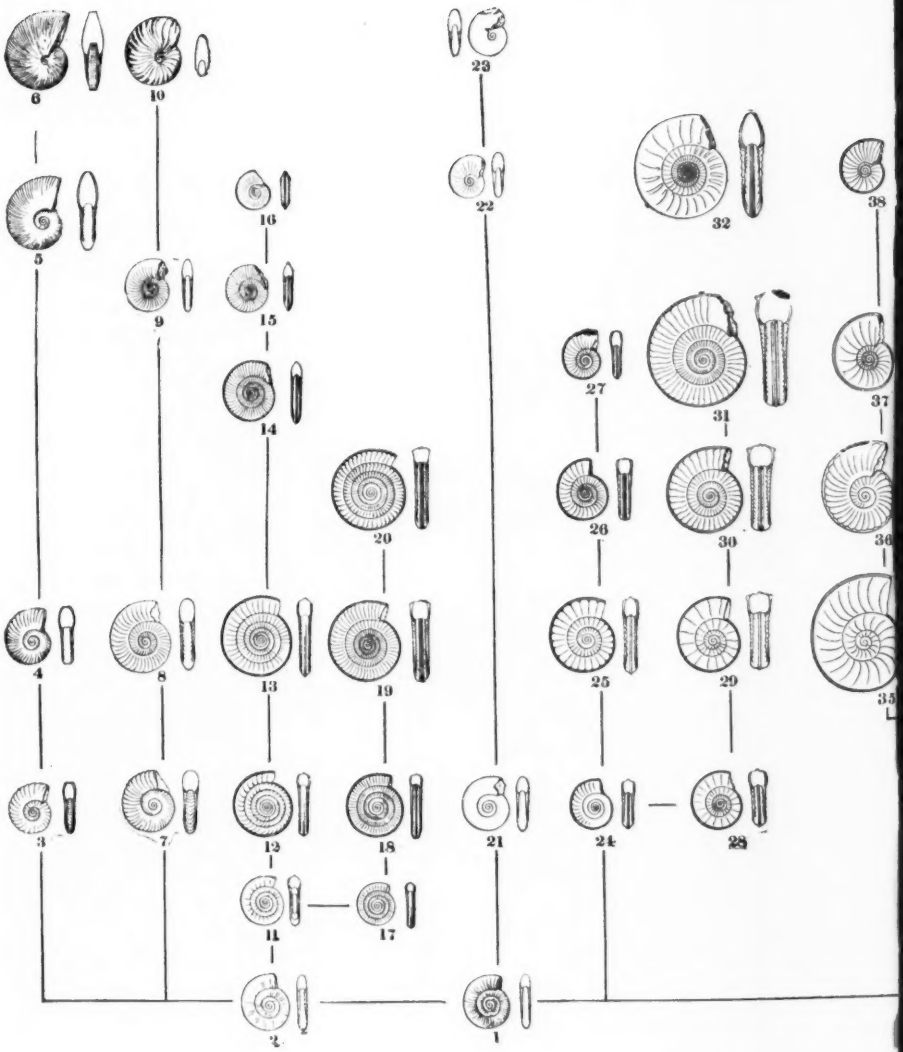
[3] Thomas, Cyrus: The Circular, Square and Octagonal Earthworks, of Ohio. Pp. 33 +iii. The Problems of the Ohio Mounds. Pp. 33 +ii. Washington Bureau of Ethnology, 1889.

that the Tallegwi formerly occupied Ohio, and were thence driven south by Huron-Iroquois and Lenapé. (We wish this bark record did not depend on Rafinesque for its authenticity.) While willing to agree with Dr. Thomas that the Cherokees have been mound-builders, we are not ready to admit that he has proved that they were the sole mound-builders, nor that he has connected them beyond a doubt with the Tallegwi, although we admit that there is a syllabic, rhythmic and vocal correspondence between the latter and the name Chellakee. In the second paper Thomas points out some of the errors of measurement in regard to the surveys of Squier and Davis' great work, besides giving accurate surveys made by the Bureau of Ethnology. "Accurate surveys," by the way, are rather amusing concoctions. We have seen a compilation of "accurate surveys" of the great Serpent Mound, the largest of which was nearly double the smallest, while two made the same week, varied about two hundred feet.

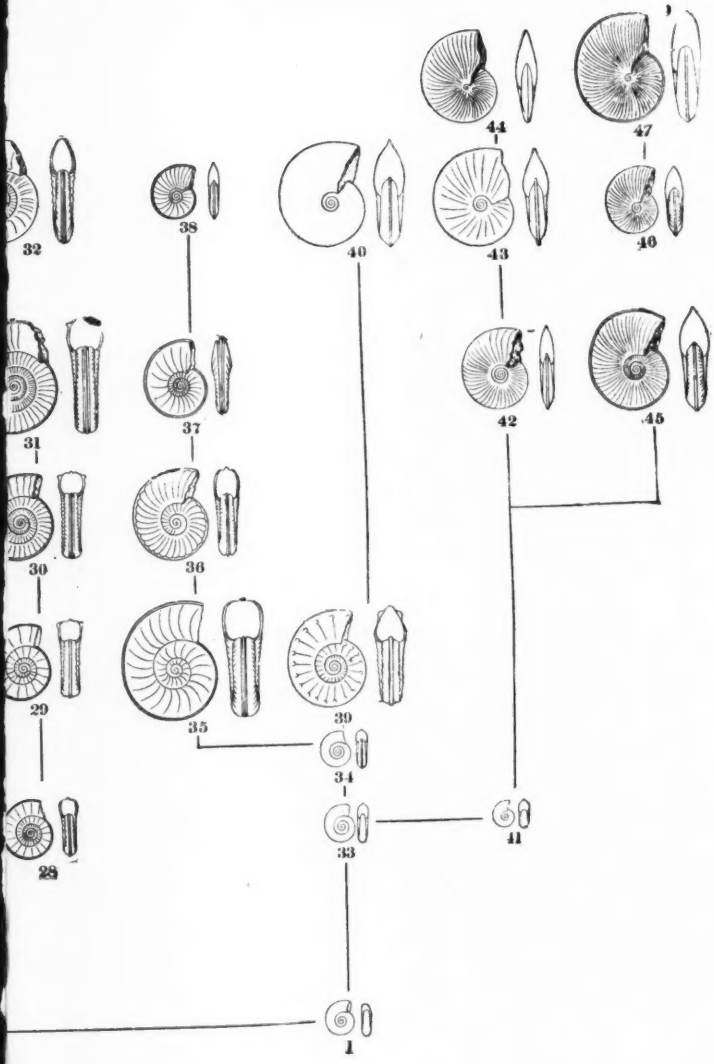
Pilling's Bibliographies.[1]—In these, as in the previously-issued Eskimo and Siouan lists, the Bureau of Ethnology has made a valuable contribution, not only for the student of American linguistics, but for those in other lines of American anthropology. The evident care bestowed upon them, the references to libraries where copies of the rarer works may be found, and the abundant bibliographical notes, make the series indispensable for all who wish to *know* something of the American Indian. To review such works is impossible; to point out omissions, or typographical errors, is but cheap criticism, but to call attention of those interested to the existence of such works is to do them a favor.

[1] Pilling, J. C.: Bibliography of the Muskhogean Languages. Pp. 114. Bibliography of the Iroquoian Languages. Pp. 208. Bureau of Ethnology: Washington, 1889.

PLATE XIX.



PHYLOGENY OF ARIETIDAE.



OF ARIETIDAE.

General Notes.

GEOLOGY AND PALEONTOLOGY.

The Genesis of the Arietidae.—This important memoir, by Prof. A. Hyatt, is the result of an effort to find a real demonstration of the theory of evolution. The methods of analysis used show the origin and rise of the ten series of species from one variety of one species, *Psiloceras planorbe*, the *Ammonites planorbis* Sow., and *Ammonites psilonotus* of Quenstedt. There are two varieties of this species, one smooth and one plicated. The smooth variety is the oldest in point of time of occurrence, and the development of the plicated variety, as well as its more recent station in time, show that it is a descendant of the smooth variety. The smooth variety is the ancestor of a series in which the forms become more involute and have more complicated sutures, but are smooth and have no keels, so that they may be accurately said to belong to the same genus, Psiloceras, as their smooth ancestor. This is pictured in Summary Plate XIV. as the central stock. On the right of this six series or genera are arranged, showing how these sprang, either directly or indirectly, from the same smooth variety of *Psil. planorbe*. On the left of the central stock or genus Psiloceras, four series are represented so as to show how these arose from the plicated variety of *Psil. planorbe*. Each series is in each case described as a distinct genus,—in fact the idea of the genus is founded upon its separability as a series of species branching off from the main stock or radical form. The last allusion to a cycle is due to the fact as shown in the Summary Plate XIV. that in each of the series there is a similar succession of forms. The forms from which each series arose were discoidal or open shells, with rounded whorls showing the internal coils plainly. As each series of forms was evolved from central stock or radical form in diverging lines like the spokes of a fan, each produced with curious iteration quadragonal whorls with keels and channels, or one or the other of these, along the periphery, and became covered with ribs on the sides. After this the successive species in each series became more and more involute in eight out of the eleven series; they lost their keels and channels, and their whorls became compressed, the abdomens at the same time tending to become acute. Thus the series of species, although

diverging very much as compared with the smooth discoidal shell of *Psil. planorbe*, they were in reality parallel to each other, that is to say each went through with a similar cycle of changes; the discoidal smooth whorl became quadragonal, and acquired keel, channels, and ribs in the species representing the acme of their progress, while after the acmatic period of the species there was a tendency to produce shell, having more involute compressed and acute whorls. Throughout all of these, however, in each series a few characteristics were acquired and transmitted by which each series might be distinguished from its allied series.

Another result is that the whole of the group of the Arietidae arose and died out within the limits of the Lower Lias, and that there are three grand faunas, the earlier, the central, and the latest in time, these three agreeing in their general characteristics with the development and decline of the individual and with the cycle shown by each series. Thus the earliest faunas are everywhere composed in the mass of simple discoidal forms, the central of still discoidal shells, but these have keels, channels, and ribs; the latest faunas are characterized by the prevalence of involute, compressed, and often smooth shells. The method of classification was the result of practical work during which the young, adolescent, adult, and old age stages of many of the species mentioned, and in most of these species all of their known varieties were studied, these observations were correlated in all directions with the observed difference and resemblance of the species. Thus the characteristics of the young and adolescent stages were compared with the adult characteristics of the ancestral forms in each series, and the characteristics of the old age of each form with those of the descendants in the same series whenever they exhibited any similar degradational characters, which was the case in nearly all series. After the series had been established by this process, succession and relation of the forms was compared with their actual succession in the rocks, and the results showed agreement in every series, except where a series, as sometimes happened, occurred altogether on the same level. In order that the evidence could be judged by the reader, lists of names of species and their level of occurrence have been given in six different tables from five different basins in Europe. It was found while following out this last investigation that in some localities new forms had arisen, and that others had received their Ammonitic population wholly or in large part by migration. The former, which were called aldainic basins, are in strong contrast with the analdainic or unproductive basins. It was found that the aldainic basins formed a band running westward, beginning in the

region of the Northeastern Alps, and that north and south of this band the basins were unproductive or analdainic. Among the aldainic basins, that of the Northeastern Alps showed by far the most ancient fauna, and all those in the aldainic zone to the westward exhibited less of the primitive or radical Psiloceran forms. Thus it is shown that even taking the minute sub-divisions of the Lower Lias, those heretofore supposed to be of the same age, by studying the life histories of the species and following out their genesis, it may be shown that they belong really to a successive series whose relations in time can be determined by the relations of their faunas.

This memoir is issued in one of the volumes of the Smithsonian Contributions to Knowledge, and also in the series of the memoirs of the Museum of Comparative Zoology, Cambridge, Mass. It is illustrated by fourteen plates, four of which are arranged phylogenetically. Plate XIV. is here reproduced as Plate No. XIX.

Explanation of Plate No. XIX.

The three preceding plates do not illustrate the biological relations of the Arietidæ as a whole with sufficient clearness, and this plate has been added for the purpose of supplying the deficiency. The series of Psiloceras has been placed in what may be deemed its true position, between the plicatus stock and the levis stock; otherwise, the arrangement is the same. The resemblances of the morphological equivalents in each series can be readily seen by following the forms along horizontal lines from left to right. The independence of the origin of these representative forms can be studied by following up the series in vertical lines, which represent descent. To a large extent, also, the more obvious differential characters which distinguish each series become appreciable by the same process.

Psil. planorbe, var. *leve*, Fig. 1; var. *plicata*, Fig. 2.

Schlot. catenata, Fig. 3, is the radical of this series.

Schlot. angulata, Fig. 4, is evidently a transition to the next species.

Schlot. charmassei, Fig. 5. The whorl is more involute, but the degenerate characters of compression in the whorls and shallowing of the abdominal channel begin to appear.

Schlot. boucaultiana, Fig. 6. The involution has attained its maximum, and the degeneration of the pilæ and channel is well marked.

Wæh. curviornatum (sp. Wäh.), Fig. 7, is undoubtedly distinct from *Schlot. angulata*, and is one of the radicals of this series.

Wæh. haploptychum (sp. Wäh.), Fig. 8.

Wæh. toxophorum (sp. Wäh.), Fig. 9, is a degenerate shell, having compressed whorls, and pilæ crossing the abdomen, as in the proximate radical *Wæh. curviornatum*. It is, however, more involute.

Wæh. emmerichi (sp. Wäh.), Fig. 10, shows a notably involute shell, with degenerate pilæ and compressed whorls.

Cal. tortile, Fig. 11, is the radical of this series.

Cal. carusense, Fig. 12, has similar young to that of *tortile* below.

Cal. nodotianum, Fig. 13, is very similar to *carusense*, but with more compressed whorls and better developed pilæ.

Cal. cycloides (sp. Wäh.), Fig. 14, shows compressed degenerate whorls.

Cal. castagnolai (sp. Wäh.), Fig. 15, is more degenerate than the last, but slightly more involute.

Cal. abnormilobatum (sp. Wäh.), Fig. 16, is a dwarfish and more degenerate form than *Castagnolai*, but has more involute whorls.

Cal. laqueum, Fig. 17, is an extreme form of this species, which approximates very closely to a true *spiratissimum*. This figure is therefore placed to the right, and under *Verm. spiratissimum*.

Verm. spiratissimum, Fig. 18, shows typical form, with but slight channels.

Verm. conybeari, Fig. 19, shows normal untuberculated variety, with stout whorls and deep channels.

Verm. ophiodes, Fig. 20, exhibits the tuberculated pilæ of this species.

Psil. aphanoptychum (sp. Wah.), Fig. 21, is one of the Plicatus stock of Psiloceras.

Psil. kammerkarense (sp. Wäh.), Fig. 22, shows the more involute and plicated form of this subseries.

Psil. mesogenous (sp. Wäh.), Fig. 23, is an involute shell belonging to the true Levis stock.[1]

Arn. semicostatum, Fig. 24. The figure represents the nearly full-grown shell; but if the keel were absent, the smooth whorls of the young would closely resemble the adult whorls of *Psil. planorbe*, var. *leve*.

Arn. hartmanni, Fig. 24, exhibits young and adult characters like those of the preceding.

Arn. tardecrescens, Fig. 26, belongs to another subseries of forms than that in which it is placed, but it serves to show that quadragonal whorled shells with channeled abdomens existed in this genus.

Arn. bodleyi, Fig. 27, shows a slightly degenerate compressed whorl, and is the terminal form of the subseries containing *Hartmanni*.

Arn. kridioides. Fig. 28 gives a view of the transition between Arnioceras and the lowest species of Coroniceras. The smooth young straight pilæ and divergent side of the adult whorl are clearly shown.

Cor. sauzeanum. Fig. 29 shows the later nealogic and ephebolic stages, having the peculiar divergent sides, flattened abdomen, and prominent

[1] Two subseries ought to have been shown here, but in trying to reduce the size of the plate the forms have been placed in the same line. A similar liberty has been taken with the subseries of Caloceras and Arnioceras, but this does not interfere with the truthful presentation of the general zoölogical relations of the forms.

tubercles of a typical coroniceran form. The young, however, still retain the smooth aspect, indicating derivation from Arnioceras.

Cor. rotiforme. Fig. 30 represents a form similar to *Cor. coronaries.*

Cor. lyra, Fig. 1. This is as a rule much smaller than *rotiforme.* The sides are more convergent, and the whorl more compressed and less numerous than in that species.

Cor. trigonatum, Fig. 32, exhibits the effects of the premature development of old age characters. Fig. 1 on the extreme right shows the dwarfed form of *Psil. planorbe,* var. *leve,* from which both the arnioceran as well as the agassiceran series may have been derived in Central Europe.

Agas. lævigatum. Fig. 33 shows the more compressed variety of this species.

Agas. striaries, Fig. 34. The striations were too fine to be represented.

Ast. obtusum. Fig. 2 shows the stouter variety with well marked channels with stout gibbous whorls and broad abdomen. This has young almost identical with the adults of the stout varieties of *Agas. lævigatum.*

Ast. turneri. Fig. 36 shows typical variety, with flattened sides and deep channels. It is notable more involute than *obtusum.*

Ast. brooki. Fig. 37 shows an extreme involute variety of this species, with very convergent sides and narrow abdomen. The channels are almost obliterated, and the keel very prominent.

Ast. collenoti. Fig. 38 gives a view of this remarkable dwarfed form, in which degeneration of the pilæ and the channels and convergence of the sides have produced morphological equivalence with *Oxyn. oxynotum* and *guibali.* The amount of the involution is greater than in any preceding species of the same series.

Agas. scipionianum. Fig. 39 shows the stouter, heavily tuberculated variety, which has young almost identical with the stouter varieties of *Agas. striaries.*

Agas scipionis. Fig. 40 shows an aged specimen in the Museum of Comparative Zoology, with extreme involute whorls, but keel still prominent. The degeneration of the adult as regards the pilæ and form can, however, be inferred from this figure. The old of *Scipionianum* at the same age is much less changed, and does not exhibit increased involution of the whorls.

Oxyn. oxynotum, Figs. 41, 42. The first figure shows the young of a variety in which at an early stage there is close likeness to the young of *Agas. striaries,* and the adults of *Agas. lævigatum.*

Oxyn. simpsoni. Fig. 43 shows the stouter form and slightly greater involution of the whorls in this species when compared with *oxynotum.*

Oxyn lymense. Fig. 44 shows the greater involution of whorls as compared with any preceding form of the same subseries, and the very acute degenerate whorl.

Oxyn. greenoughi. Fig. 45 shows the stout form of the whorls better defined, and pilæ of this subseries as compared with the *oxynotum* subseries.

Oxyn. lotharingum. Fig. 46 shows the smaller size of this species, and the degeneration of the pilæ. The involution of the whorls is, however, greater than in any preceding species.[2]

Oxyn. oppeli. Fig. 47 shows the extremely involute form of the Middle Lias. The stout whorls indicate that no great amount of degeneration had taken place. It may have been a direct descendant of *greenoughi.*

The Age of the Gay Head Bluffs at Martha's Vineyard.—At the last annual meeting of the Geological Society of America, Mr. Lester F. Ward remarked: "My principal object in coming to this meeting was to listen to this paper, as I was associated with Mr. White in his work and am deeply interested in it.

"I desire merely to emphasize the great importance of the results at which he has arrived. Not until the past season has anything definite been known of the fossil flora of Martha's Vineyard, the few fragments figured by Hitchcock not having been determined, and having no geognostic value. As Mr. White has remarked, the ablest geologists in the country have long been at work upon the question of the age of the Gay Head beds, and, as shown by the older as well as by recent papers, especially those of Professor Shaler, great differences of opinion and doubt as to their age have prevailed.

"The discovery by Mr. White of undoubted Cretaceous fossil plants has settled that question as far as the particular strata from which these plants were found are concerned. In all his recent papers, including the one read before the Society on Thursday last (pp. 443–452), Professor Shaler has insisted that all except the very base of the Gay Head section is Tertiary and even Miocene or Pliocene.

"I do not pretend that the entire section at Gay Head and Nashauitsa cliff is necessarily Cretaceous. The plants were found in the Gay Head section near the middle, and it is very possible that, considering the extent of the beds and the length of the section the overlaying strata may be Tertiary, even Miocene. But if if there is a great thickness lying above these beds, so there is a great thickness lying beneath them, and therefore the section must extend far down into the Cretaceous. It would seem then that Mr. White's investigations during one short season have done more to settle the age of these beds than all that has been done before.

[2] The extreme old age of this form is marked by decrease in the amount of involution of the whorl, and also by the loss of the prominent hollow keel.

"I gladly testify to the indefatigable zeal with which Mr White pursued his investigations against the greatest difficulties and discouragements. It required much careful thought and labor to ascertain in what particular manner the plants were preserved; but after this had been fully settled he was very successful in finding them, although they were not abundant; and he persisted until his collection amounted to five barrels of very excellent material, which is being elaborated at the National Museum."

F. J. H. MERRILL said: "It is seldom that an opportunity is afforded for determining the true stratigraphy of the Gay Head section. The speaker visited it in 1884, and concluded as a result of his examination that the beds were extensively repeated by faulting; but on visiting the locality in 1887, with Professor N. S. Shaler, he found the aspect of the section so much altered by landslides that he was unable to show the evidence upon which he had based his conclusion. Subsequent exposures have again revealed the truth as reported by Professor Shaler at this meeting (*ante*, pp. 443–452). During his first visit the writer found a number of clay-ironstone nodules enclosing fragmentary leaf-prints, which were considered by Dr. Newberry to be of Cretaceous age, but the impressions were poorly preserved and their nidus in the section was uncertain, so that no decisive value could be attached to them. Although the Cretaceous leaf-prints reported by Mr. White were undoubtedly in place, they do not prove the Cretaceous age of the whole Gay Head section. They are from the lower half of the series. The greensand beds, which are in the upper half, contain Miocene Tertiary fossils, shark teeth of the genera *Charcarodon* and *Oxyrhina*, bivalve casts, probably of *Tellina biplicata*, Say, and fragments of crustaceans. This greensand deposit is apparently secondary, having been derived from some pre-existing bed and redeposited under conditions of disturbance and violence abnormal to greensand beds. The crustacean fragments in particular have been much rolled and wave-worn. On this evidence we may conclude that the greensand beds were laid down not earlier than the close of the Miocene.

"The opinion of the writer that the Gay Head strata were post-Pliocene was chiefly based on the evidence of a stratum of post-Pliocene sand, which is the uppermost member throughout the section, being repeated frequently by faults at one point containing fragments of *Venus mercenaria* and other Quaternary shells. As this bed is apparently comformable to those beneath it, the writer concluded that a considerable portion of the Gay Head series, if not the whole of it,

was laid down in post-Pliocene time. It may be, however, that future investigation will demonstrate the presence of Cretaceous, Tertiary, and Quaternal strata at Gay Head."—*Bulletin Geol. Society of America, Vol. I.*

The Age of the Laramie.—At the meeting of the Geological Society of America, held at New York, December, 1889, Mr. Lester F. Ward remarked: "I take it that the discussion here to-day should avoid, as far as possible, repetition of the statements that have already been published. Like Dr. Newberry, I have in my hands a large amount of material, both from the typical Laramie group and from the Fort Union group, which has not been published. A few years ago, as you all probably know, I did publish a paper on the Laramie group, to which I prefixed a prefatory discussion in regard to the probable age of that group. In that discussion I admitted that there was the same lack of identity between the Fort Union fossil plants and those of the lower Laramie which Dr. Newberry has pointed out. In further investigations of this material (for at that time I had only studied a small portion of it, except in a very general way) I have not had any occasion to alter my opinion in that respect, and I am to-day prepared to say what I said then and what Dr. Newberry has said this morning, viz., that so far as the floras of the Fort Union group and of that which was originally called the Laramie beds of Colorado, Wyoming, and New Mexico are concerned, they are not identical—they are very different.

"I hazarded a possible explanation in case the geologists and animal paleontologists eventually establish the synchrony of those beds, viz., that possibly the latitude taken in connection with a different topography such as may have existed in the two regions might account for the great difference in the floras. But I also expressed the opinion that in all probability there would eventually be found a difference of age—how great it would be premature for me to say. The great difference is not so much in the species as in the general facies of the two flora. There are eight or ten identical species[1] in the Laramie and Fort Union, but these weigh very little in comparison with the more important fact that

[1] The species common to the Laramie of Colorado and Wyoming and the Fort Union group, as shown in the table of distribution given in my Synopsis of the Flora of the Laramie Group (Sixth Annual Report U. S. Geol. Survey, 1885, pp. 443-514), as follows: *Sequoia langsdorfii, Sabal campbellii, Quercus olafseni, Juglans rhamnoides, Juglans rugosa, Ficus tiliæfolia, Magnolia hilgardiana, Trapa microphylla.*

These are exclusive of several species thus far only found in the Laramie of British Columbia, one of the America areas, as also of a number of more or less doubtful cases.

in the lower Laramie—the original Laramie formation—there is a large predominance of such genera as *Ficus*, and also many palms, which, to the mind of a paleobotanist naturally and probably correctly suggest a warmer climate.

"Whatever may be true in regard to the difference of age—and it seems to me that the two must go together—I am quite satisfied that a warmer climate prevailed during the period of the deposition of the Wyoming and Colorado beds than that which prevailed during the deposition of the Fort Union beds. Among the leading genera of the upper beds are *Populus* and *Platanus*. Some of these forms are, I admit, very irregular and peculiar, but they are not found in any such abundance least, grow in the colder climates, and very few species of *Ficus*, very few in the lower beds. They are more northern forms—forms which now at genera of palms, are found, so far as my own collection is concerned, in the Fort Union beds. Moreover, as Dr. Newberry has stated, there are forms in the Fort Union which have an exceedingly recent facies, but I am very loath to argue from this a Tertiary age. For instance, there are what seem to be the leaves of the identical species of hazel which grows now in the eastern parts of the United States; yet I hesitate to argue from this that the formation is necessarily very recent.

"In fact, the material from the Fort Union formation which is still in my hands (partly for the reason that I was unable to identify it with the published flora of the globe, and partly because I was unable to publish more at that time) inclines me to believe that there would really be, as I then stated, no inconsistency in assigning to the Fort Union an age as ancient as the closing period of the Cretaceous system. Some of the facts I might enumerate here, but this would be perhaps tedious; but some of the forms are certainly not to be identified with any of the genera that have been found in the fossil or the living state. Such forms cannot be regarded as having geological importance in fixing age, yet they go a long way in the direction of showing us that the age may be more ancient than has been supposed. The genus *Trapa* has been found in both groups, but I am not thoroughly satisfied that the species are identical. In my anxiety not to multiply species, I called it by the name given to the form described by Lesquereux from the Point of Rocks beds, though it may prove to be a distinct species; yet we may never know, from the fact that the material collected by him was inadequate. I have collected from the Fort Union beds specimens of that plant containing entire rosettes of leaves as they would lie on the surface of the water, and showing to my mind

that it must have belonged to the genus *Trapa* or a closely related form. The Point of Rocks material contained nothing but isolated leaves—that is to say, there were no rosettes and there were no stems —simply the form and nervation of the leaves. These point to the genus *Trapa*, and the probability is that they belong to that genus.

"The evidence afforded by the beds at Black Butte station, where the great saurian was discovered by Professor Cope, is perfectly conclusive of the identity of the age of the beds from which that fossil was taken with that from which the leaves of that particular locality were taken. We have at the National museum a specimen of the bone from that creature, adhering to the opposite side of which is one of the characteristic Laramie leaves. I have been on this spot, and collected other fossil plants from the same immediate locality.

"Now, with regard to the error, if error there be, in harmonizing or identifying the Laramie and Fort Union deposits: I suppose the responsibility for this must largely rest upon Dr. C. A. White, who has made a very thorough and exhaustive study of the entire region, as he defines it from the standpoint of its molluscan fauna; and it seems to me that his identification of the two groups—and I have conversed with him very freely and very much upon this subject, and what I say is from memory of the oral statements made by him—was in the nature of a broad, geological generalization. He, in his extensive labors in that field, simply came upon the salient fact, that throughout the larger part of the region now occupied by the Rocky Mountains is abundant evidence that there existed at a remote period, somewhere near the close of the Cretaceous or beginning of the Tertiary period, a great land-locked sea, originally somewhat salt, later brackish, and finally nearly fresh; and that the deposits which were made at the bottom of the sea are apparently continuous all the way up from the pure marine deposits of the upper Fox Hills group to the highest of Fort Union deposits; and he even ventures to say he has traced it in some places still higher into strata which are admitted to be Tertiary.

"I have one fact of my own observations which may be worth stating, and which may not be known to all. About 15 miles above the town of Glendive, on the right bank of the lower Yellowstone river, there is a cliff, known as Iron bluff, which is colored very bright red from having the carbonaceous matter burned out, and which is full of fossil plants. It is also full of the characteristic Laramie shells, such as Dr. White has described and has daily met with throughout the Laramie series. These shells, he informs me, are identical all the way through the Laramie from bottom to top. There is nothing to indi-

cate that there is any difference in the age, so far as the indication from the shells is concerned. This bluff is right on the bank of the Yellowstone river, and the railroad cuts through it, which makes the cliff there conspicuous. Immediately below there is a short anticline, apparently a little island about a mile in extent, filled with characteristic Fox Hills Cretaceous fossils. I have been on the ground and collected large numbers of them, and everywhere we meet with them: the wheels of the wagon as one drives over them crush the shells, so abundant are they; and there is do doubt that this is a typical Fox Hills bed, in Dr. White's understanding of the term "Fox Hills." Now, as far as I can tell, and so far as he could tell from a careful study of the ground, this Iron bluff deposit—this Laramie or Fort Union leaf-bed—rests directly and immediately upon the Fox Hills bed. If there is any difference of age there is no indication at that point that it has been wanting from lack of comformity or from any other cause; and it is certainly a very natural conclusion that when one deposit rests comformably upon another at one point, and when at another point two formations, the lower one being the same as in the first case, have the same order and arrangement, the age of the overlying beds in both regions is the same. That seems to be as clear a case of geological reasoning as we have.

"I observe that our friends across the border, of whom we have representatives here, are still using the term Laramie for this formation. It seems to me that the bulk of their Laramie is nothing more or less than our Fort Union, and they seem to be somewhat in doubt (at least so I learn from reading a paper which reached me only a day or two before I left Washington, with a Christmas greeting from Sir William Dawson); and I do not know but that we might as well settle the question in the way he has settled it in that paper as in any other way. He simply says that the time may yet come when, in fixing our arbitrary position for the line between the Cretaceous and the Tertiary, we may be obliged to draw it through that continuous deposit which we call the Laramie group.

"Dr. Newberry's memory is entirely at fault when he says that in my "Synopsis" I called the Laramie and Fort Union group Tertiary. I have been criticised for arguing that they are Cretaceous. As a matmer of fact, I did not call them the one or the other, or argue for either view. I first gave a perfectly unbiased review of opinion, in which the advocates of each view were allowed to state their case in their own words. I then did what had never before been done. I presented the evidence from the fossil plants upon both sides in tabular form, getting

together for the first time a fairly complete list of all the upper Cretaceous species the existence of which had generally been ignored in the discussion of the question. These as well as the Eocene species of all parts of the world were directly compared with the Laramie species. The very careful analysis of this table which I made showed that the Laramie flora occupies an intermediate place between that of the upper Cretaceous (above the Dakota group and Cenomanian) and that of the Eocene. The only conclusion I drew, if conclusion it can be called, was that the whole discussion was a war of words, often unworthy of the talent that had been expended upon it."

PROF. J. J. STEVENSON said: "I should like to say a word or two about the section that Dr. Newberry has put on the board. The statement that the Colorado group cannot be differentiated in Colorado is not altogether correct. It is true that in a considerable area beyond the Arkansas range it is a very difficult thing indeed to differentiate the Colorado group; but along the plain in front of the Rocky Mountains in Colorado and New Mexico there is not the slightest difficulty in recognizing the Fort Brenton as a mass of black shale; the Niobrara above that, gray to blue limestones separated by black shale; then the Fort Pierre, drab to yellow sandy shales, containing nodules of limestone and iron ore, while above that and quite easily separable from it we find in northern and central Colorado the Fox Hills group. This is the Cretaceous along the waters of the South Platte, where the Fox Hills group is characterized all the way, from the bottom to the top, by a nodose fucoid, *Halymenites major*, which was at one time a very interesting topic of discussion. The Fox Hills group in central Colorado is upwards of one thousand feet thick, consisting mostly of sandstones, some of them calcareous and rich in Fox Hills fossils, with some beds of coal, which have been opened in the neighborhood of Greely. At Cañon City, Colorado, the Fox Hills group is only about 250 feet thick, that being the vertical extent of the *Halymenites*. In that interval are the important coal beds and numerous sandstones or shales containing plants which doubtless answer to those of the plant bed which I found on one occasion near Evans, on the South Platte, but which I could never find again. Further southward, near Trinidad, Colorado, the Fox Hills is only 80 feet thick, that being the vertical range of the *Halymenites*. In that field, however, the Fox Hills has been included in the Laramie; but the Laramie group above the great coal-bearing series is easily separable from the *Halymenites* sandstone. Southward, in New Mexico, the *Halymenites* or Fox Hills sandstone entirely disappears.

"The point I wish to make is that the upper Missouri section of the Cretaceous is distinctly recognizable as far south as central Colorado. Beyond that southward the Fox Hills thins out until it disappears in New Mexico, but the other members of this section can be recognized without any difficulty in front of the Rocky Mountains and around their southern end to the Rio Grande."

PROF. E. D. COPE said: "It seems to become more complicated the more we investigate, and a greater number of problems arise to be solved. What Professor Stevenson has just stated is established. I can demonstrate from my own observation what Dr. Hayden has stated —that is, the conformity of the four or five gradations with the Laramie above. There seems to be absolutely no disturbance or want of conformity in the upper Missouri between those three horizons. I could get the Pierre fossils in the bottom of the bluff and Fox Hills in the middle and Laramie at the top. On the question of the Laramie's position in the Cretaceous or Tertiary series the vertebrate fossils throw some light. The reptiles and saurians are Cretaceous. I have discovered in New Mexico the Puerco series just above the Laramie, and in that I have about a hundred species of the mammalia. I have also discovered mammalia in the Laramie. Professor Marsh has added some species to those previously known. These species are of identical character with the Puerco mammals, although there is no species identical with any in the Puerco, where there is not a single Cretaceous reptile. The mammals of the Laramie are, like the saurians, rather Cretaceous than Tertiary; but the character is not so pronounced."—*Bulletin Geol. Soc. Amer., Vol. I.*

Prof. Marsh on Hallopus and other Dinosaurs.—In the May number of the *American Journal of Science* a paper is published by Prof. Marsh, entitled, "Distinctive Characters of the Order Hallopoda." The conclusions which I have reached, after a study of the type specimen, do not agree at all with those of the Professor. I cannot find sufficient evidence for the correctness of the following statements:

1. "There were but four digits in the manus, the first being short and stout, and the other slender."

2. "The fibula was slender and complete, but tapered much from above downward. Its position was not in front of the tibia below, as in all known Dinosaurs, but its lower extremity was outside, and apparently somewhat behind, the tibia."

3. "The calcaneum is compressed transversely, and much produced backward. It . . . strongly resembles the corresponding bone in some mammals."

There is no definite proof that the bone called "calcaneum" represents this element, or that the first digit of the hind-limb was entirely wanting.

Hallopus is a true carnivorous Dinosaur, near to Compsognathus, there can be little doubt. This opinion was expressed already by Prof. Williston in 1878, in a paper published in a Journal of the Kansas Academy of Science, the title of which I cannot give at this moment.

In the following paper a new order of Dinosaurs, "Ceratopsia," is created. *Ceratops* Marsh, 1889, is the same as *Monoclonius* Cope, 1876. This I can state with absolute certainty, having examined the types of Ceratops and Monoclonius. Neither "Ceratopsidæ" nor "Ceratopsia" can be adopted on this reason. The so-called "Ceratopsia" are characterized by Professor Marsh in the following way:

"(1), The skull surmounted by massive horn-cores; (2), a rostral bone forming a sharp, cutting beak; (3), the teeth with two distinct roots; (4), The anterior cervical vertebræ coössified with each other; (5), the pubis projecting in front, and no post-pubis."

To this I have to make the following remarks:

1. The skull of Phrynosoma is surmounted by stout horn-cores, but nobody will place it on that account in a separate order. On the same reason the horned members of the Cervidæ could be placed in a different order from the hornless forms.

2. Some of the pigs and edentates have a peculiar bone in front of the nose, not present in other mammals, but nobody places these forms in a separate order on this account.

3. If the teeth would really have two distinct true roots, as Prof. Marsh states, this perhaps would be of ordinal character, but I do not believe it. These "two roots" are probably produced by splitting of the tooth by the young one following.

4. In Buceros among birds, also in some of the Plesiosauria and Ichthyosauria, the first two vertebræ are firmly coössified; are they placed in separate orders therefore?

5. "The pubis projecting in front, and no post-pubis." Everybody knows to-day that what is called by Prof. Marsh the pubis is the pectineal process, and that his post-pubis is the true pubis. The statement that there is no post-pubis I do not believe before it has been demonstrated that the bone called pubis by Prof. Marsh and repre-

sented complete, is really complete. I doubt it, and believe that there was a "post-pubis," which is simply broken away in the specimen.—GEORGE BAUR, Ph.D. *New York, May 7th, 1890.*

[NOTE ON THE ABOVE.—The "two-rooted teeth" described by Prof. Marsh, and referred to above by Dr. Baur, are not such in point of fact. The appearance of two roots is produced by the absorption of the middle part of a single root by the crown of the successional young tooth. After the absorption has progressed sufficiently far, the less direct of the two branches is generally broken off, so that teeth with both preserved are less abundant than those with a single half-root. Teeth of this kind were figured by Leidy as belonging to Trachodon, and were described by me as representing the new genus Dysganus in the Proceedings of the Philadelphia Academy for 1876. They are very abundant in the Laramie formation.—E. D. COPE.]

Extinct Quadrumana.—Professor Gaudry has published in the new Memoirs of the Geological Society of France an interesting paper on the *Dryopithecus fontanii* Lartet, of which a new mandible has been recently discovered in France. This mandible is more perfect than any hitherto obtained, as it has the symphysis with the incisor teeth, and all the molars except the last of one side. Prof. Lartet supposed that the genus Dryopithecus approached nearer to Homo than any of the existing apes, on account of the probable later appearance of the m^3 (wisdom tooth) than in the latter. Prof. Gaudry's specimen shows that the symphysis is longer than in any of the existing anthropoids, and that the anterior premolar is relatively larger. Its relationships are therefore not towards Homo, but away from him, and towards the true monkeys. The last inferior molar was evidently erupted at about the same time as the inferior canine, and not before it, as in many monkeys; but Gaudry shows that in several monkeys and apes the period of protrusion of the m^3 is the same as that seen in the Dryopithecus. The latter is nearer to the gorilla in dentition than to either the orang or chimpanzee. It was smaller than either.

Under the name of *Dolichopithecus ruscinensis*, M. Charles Deperet describes in the *Comptes Rendus*, a species of monkey, of which a skull was found by Dr. Bonneman near to Perpignan, together with numerous other bones. The dentition is in general that of Macacus, but the limbs have the slender proportions of those of the Semnopithecus. The genus is then close to the Mesopithecus of Gaudry, from which, indeed, M. Deperet does not satisfactorily separate it. It differs from the *M. pentelici* by its larger size, larger face, and larger heel of the last inferior molar. The monkey of the Val d' Arno, *Aulaxinus florentinus*, is still smaller, and has a much shorter muzzle.

MINERALOGY AND PETROGRAPHY[1]

Mineralogical News.—The long expected monograph by Brögger[2] on the minerals of the syenite-pegmatite veins of the augite syenite and nepheline syenite region of Southern Norway has at last made its appearance. The special part of the volume, which describes in great detail seventy mineral species, is prefixed by an introduction of 235 pages, in which the geology of the region is discussed and the eruptive nature of the pegmatite veins is proved. An abstract of this portion of the work will be given in another place. Of the seventy mineral species recognized in the veins five are of sulphides, one is a sulpho-salt, three are oxides, three are hydroxides, one is a haloid compound, one a ferrate, two are borates, two phosphates, two are members of the zircon group, three belong to the epidote group, two to the group of the datholites, three to the garnets, three to the micas, two to the nepheline group, two to the leucophanes, seven to the pyroxenes, four to the hornblendes, four are members of the melanocerite group, three are feldspars, seven are zeolites, and nine others are various silicates. The only carbonate detected, beside two fluo-carbonates, is calcite. It is evidently impossible to mention even all of the important discoveries made by the author in his studies of the wonderful suite of specimens collected by him. We can only refer briefly to the most important of them. Measurements of *löllingite* yielded $a : b : c = 6689 : 1 : 1.2331$. Tabular crystals of *hydrargillite* gave $a : b : c = 1.7089 : 1 : 1.9184$; $\beta = 85° 29' 10''$. These are occasionally untwinned, but more frequently twinned forms are found in which the twinning planes are ∞P (corresponding to DesCloizeaux twins par. $\infty P\bar{\infty}$), $\infty P\bar{\infty}$ (occasionally), $\frac{1}{15} P_{\bar{3}}$ (?), and oP; and a fifth form in which the twinning plane is perpendicular to oP. Optically, plates of the mineral act uniaxially. *Xenotime*, while containing many elements, yielded upon analysis figures that may be reduced to correspond to the formula $Y_2(PO_4)_2$. An examination of thin sections of *orthite* (*allanite*) shows its extinction in $\infty P\infty$ to vary between 37½° and 28½° in acute β. The plane of the optical axes is perpendicular to $\infty \breve{P}\infty$, and the double refraction is negative. Analysis of carefully purified *homilite* gave:

SiO_2	Al_2O_3	Fe_2O_3	Ce_2O_3	B_2O_3	FeO	CaO	Na_2O	H_2O
31.83	2.72	.88	.24	16.51	16.74	29.54	.75	.79

[1] Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.

[2] *Zeits. f. Krystall.*, XVI. Specialler Theil, 664 pp., XXVII. Pl.

Single crystals are described, and twins following four twinning laws are well illustrated in the plates. The optical properties of the mineral are briefly sketched. Several varieties of *garnet* are mentioned, two analyses of which are worth recording. The black-green garnet of Stokö and the yttrium garnet of the same localiy contain resectively:

SiO_2	TiO_2	Al_2O_3	Fe_2O_3	Mn_2O_3	Y_2O_3	MnO	MgO	CaO	Na_2O	H_2O
34.90		8.97	20.43			2.40	tr.	31.38		1.27
31.51	3.52	2.01	26.68	2.15	.38		.38	30.78	.79	.43

Nordenskjöldite, with an axial ratio of $a : c = 1 : .8221$, has a composition corresponding to Ca $(BO)_2$ SnO_4. *Astrophyllite*, as the result of new measurements, is concluded to be orthorhombic with $a : b : c = 1.0098 : 1 : 4.7556$. Its fracture figure (on the perfect cleavage parallel to $\infty P \infty$) consists of two lines crossing each other at angles of about 81° and 98°, the smaller of which is bisected by the vertical axis. The gliding planes correspond very nearly to those of the dome $\frac{1}{4} P\breve{\infty}$. The axial plane is the base, with b the positive acute bisectrix. A new analysis of carefully purified material shows slight differences from the previously published analyses, and corresponds closely to the formula $R_4'' R_4' Ti (SiO_4)_4$. *Leucophane* crystals to the number of twenty gave good enough reflections to enable Brögger to determine without difficulty their orthorhombic symmetry, $a : b : c = .9939 : 1 : .6722$. The axial plane is the macropinacoid and c is the negative acute bisectrix. $2E_{Na} = 74° 15'$. *Melinophane* crystalizes in the tetartohedral division of the tetragonal system. Optically it is uniaxial. Chemically it differs from leucophane [$Na_3 (F Be)_3 Ca_3 (SiO_3)_6$] in containing more beryllium [i. e. it is $Na_2(FBe)_2 (Ca_2O)_2 Be_2 (SiO_3)_6$]. A thorough discussion of the characteristics of *acmite* and *ægerine* leads to the view that they are well marked varieties of the same pyroxene, closely related to diopside. Acmite is nearly always twinned, while ægerine is usually in simple crystals. *Làvenite* according to the most recent measurements has $a : b : c = 1.0963 : 1 : .7151$ and $\beta = 69° 42\frac{1}{2}'$. *Wöhlerite* usually occurs in twins, whose twinning plane is the orthopinacoid. When placed in the conventional position for pyroxene its axial ratio becomes $a : b : c = .9966 : 1 : .3547$ with $\beta = 89° 18' 50''$. Its absorption is $C > B = A$, and pleochroism varies between yellow and colorless shades. *Làvenite* and *Wöhlerite* are regarded as zirconium pyroxenes, closely related to the corresponding triclinic pyroxene *hiortdahlite*. *Polymignite* crystals are orthorhombic, as is well known, with the axial ratio .7121 : 1 : .5121. Their hardness is 6–6.5, and density 4.77–4.85. Chemically and morphologically the mineral is

closely related to *æschynite*, with which it forms a group distinct from all other natural mineralogical groups. When placed in a position corresponding to the usual one for æschynite its axial ratio becomes $a : b : c = .4681 : 1 : .7192$. Measurements of the best *arfvedsonite* crystals gave $.5496 : 1 : .2975$ as the axial ratio for this species, with $\beta = 75° 44\frac{1}{2}'$. The analysis of a large crystal yielded (after treating with acid to dissolve magnetite):

SiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	Na_2O	K_2O	H_2O
49.90	2.62	32.99	.05	.57	12.88	.10	1.07

Pterolite is regarded as an alteration product of barkevikite, consisting of a mixture of lepidomelane and ægerine, and *ainigmatite* is thought to be identical with cossyrite. An optical examination of *katapleite* proves it to be monoclinic with $a : b : c = 1.7329 : 1 : 1.3618$ and $\beta = 89° 48\frac{1}{2}'$, and not hexagonal as formerly supposed, although it assumes the hexagonal symmetry when heated to 140°. Two varieties of the mineral are recognized. The first is a yellow variety to which the name katapleite is assigned, and the second a blue variety which is called *soda-katapleite*. The composition of the varieties is given as follows:

	SiO_2	ZrO_2	Al_2O_3	FeO	CaO	Na_2O	H_2O
I	41.56	32.53	1.02		5.21	9.74	9.35
II	44.04	30.94		.10	.87	14.94	9.24

Tritonite, according to Brögger, does not crystallize in the regular system, but is probably rhombohedral and hemimorphic. In this case $a : c = 1 : 1.114$. The analyses that have been published as those of *Erdmannite* are thought to be analyses of a mixture of a melanocerite mineral with a member of the homilite group. *Eukotite-titanite* is a deep brown variety of sphene, with most of the optical and crystallographic properties of this mineral, but differing from it slightly in composition, which is as follows:

SiO_2	ZrO_2	TiO_2	CeO_2.	Ce_2O_3	Y_2O_3	CaO	FeO	MgO	Na_2O	K_2O	Loss
30.22	.18	34.78	2.57		.59	24.38	3.84	.50	.86	.27	.31

The *soda-orthoclase* of Fredriksvärn turns out upon close examination to be an intergrowth of such fine lamellæ of albite and orthoclase, that upon examination with low powers of the microscope, a section of this mineral behaves as if monoclinic. Brögger calls it *cryptoperthite*. *Eudidymite* has been carefully examined and its properties well established. It is a monoclinic mineral, resembling in appearance heulandite. Its axial ratio is $a : b : c = 1.7107 : 1 : 1.1071$, and $\beta = 86° 14'$

27″. It occurs in tabular crystals, with a perfect cleavage parallel to the base; a hardness of 6 and a specific gravity of 2.553. The extinction in $\infty P\bar{\infty}$ is inclined 58½° to *c* and 27° 45′ to the clearage parallel to oP. $2V_a = 29° 55'$ for sodium light. Very exact measurements of a large number of *natrolite* crystals from Little—ar δ indicate that the mineral is monoclinic with $a : b : c = 1.0165 : 1 : 1.3599$, and $\beta = 89° 54' 52''$, and not orthorhombic as is usually assumed. The orthorhombic symmetry, which is ordinarily observed, is due to twinning parallel to the orthopinacoid. These monoclinic natrolites differ from the ordinary orthorhombic form in containing a small quantity of potassium. The extinction angle increases with the potassium content. *Bergmannite* and *brevicite* are shown by the author to be either natrolite, or mixtures of this mineral with several other substances.

New Minerals.—*Hambergite.* A single specimen of this mineral is of grayish white color, and is orthorhombic with ∞P, $\infty P\bar{\infty}$, $\infty P\breve{\infty}$ and ∞P. $a : b : c = .7988 : 1 : .7267$, and hardness=7.5. Sp. Gr.= 2.347. Plane of the optical axes is ∞P, $\breve{\infty}$ and *c* is the acute bisectrix. 2Vna= 87°7′ (observed) or 87° 40′ (calc.). Analyses yielded: BeO=53.25%; H_2O=10.03; B_2O_3=36.72; =(HO) Be_2BO_3. ——*Johnstrupite* was originally confused by Brogger with mosandrite, which it resembles in many respects. Careful observation shows its axial ratio to be $a : b : c = 1.6229 : 1 : 1.3594$. $\beta = 86° 55½'$, and the plane of its optical axis the clinopinacoid, with the positive acute bisectrix inclined 2½° to *c*, in which it closely resembles mosandrite. The latter mineral however is reddish brown when fresh, while johnstrupite is brownish green. That they are two distinct minerals is shown by their composition, which corresponds respectively with the formulas $(OH)_6F_2H_{12}R_4Na_2Ca_{10}Ce_2(SiO_4)_{12}$ for mosandrite, and $F_7H_2R_3Na_6Ca_{13}Ce_2MgAl(SiO_4)_{12}$ for johnstrupite. The similarity in composition and morphological properties between these two minerals and epidote leads the author to regard them as members of same group.—— *Calciothorite* is a deep reddish brown amorphous substance, with a hardness of 4.5 and a sp. gr. of 4.114. Its composition is:

SiO_2	ThO_2	Ce_2O_3	Y_2O_3	Al_2O_3	Mn_2O_3	CaO	MgO	Na_2O	H_2O
21.09	59.35	.39	.23	1.02	.73	6.93	.04	.67	9.39,

corresponding to $5ThSiO_4$ $2[Ca_2SiO_4]$+ca. $10H_2O$.——*Hiortdahlite* is a triclinic pyroxene occurring in small, thin, tabular crystals of a yellowish or yellowish brown color Its crystallographic constants are $a : b : c = .9981 : 1 : .3537$, $\alpha = 89° 30' 57''$, $\beta = 90° 29' 6'$, $\gamma = 90° 6' 10''$. The crystals are elongated in the direction of the

vertical axis, and are flattened in the direction of the macropinacoid. Like wöhlerite, nearly all hiortdahlite crystals are twinned. In the latter case the twinning plane is at right angles to the vertical axis, and the combination face is the macropinacoid. The axial angle is large. The optically positive first bisectrix is sharply inclined to the vertical axes. The extinction on the $\infty P\bar{\infty}$ is 25° and on $\infty P\breve{\infty}$ is about 15½°. No well marked cleavages are observed in any sections. The specific gravity is 3.235—3.267, and the composition:

SiO_2	TiO_2	ZrO	ZrF_2O	Fe_2O_3	FeO	MnO	CaO	MgO	Na_2O	H_2O
31.89	1.50	2.88	22.00	.34	.94	.96	32.53	.10	6.53	.58

——*Cappelinite*, the discovery of which was announced some years ago by Brogger, occurs in hexagonal prisms with ∞P, $\frac{1}{3} P$ and P. $a : c = 1. : 1.2903$. Their double refraction is negative and their composition is as follows:

SiO_2	B_2O_3	Y_2O_3	La_2O_3	CeO_2	ThO_2	BaO	CaO	Na_2O	K_2O	Loss
14.66	16.98	52.62	2.97	1.29	.80	8.29	.67	.53	.22	.61,

corresponding to the molecular combination of $R_2^{IV}(SiO_3)_2$ and $R^{IV}(BO_3)_2$. The hardness of the mineral is 6, and its specific gravity is 4.407. It is regarded as a member of the melanocerite group, to which also the following named mineral is supposed to belong. This mineral, *karyocerite*, is likewise hexagonal. Its axial ratio is 1 : 1.1845, and its specific gravity 4.295. It differs from melanocerite in containing much more cerium and thorium (CeO_2 and ThO_2). It occurs in nut-brown tables with a rhombohedral habit.——*Weibyeite* occurs in small crystals with a tetragonal habit. In form they resemble zircon, but are really orthorhombic, as their optical investigation shows, with the vertical axis that of least elasticity. $a : b : c = .9999 : 1 : .64$. It was impossible to separate the mineral from the pairsite associated with it, but an analysis of the mixture leads to the view that weibyeite corresponds in composition to the formula $[(Ce,La,Di)F]_2(CO_3)_2$.——*Barkevikite*, although long known as a variety of hornblende, has received but little attention in recent years. A new analysis shows it to have the following composition:

$TiSiO_2$	Al_2O_3	Fe_2O_3	FeO	MnO	CaO	MgO	Na_2O	K_2O
42.46	11.45	6.18	19.93	.75	10.24	1.11	6.08	1.44

Although chemically not very different from arfvedsonite, its physical properties readily distinguish it from this species. The extinction is 12½ in the acute β, while in arfvedsonite it is in obtuse β.

This latter mineral is pleochroic in blue and green tints, while the former is pleochroic in brown and brownish red tints. Barkevikite is an essential constituent of the augite syenite occurring between the fjords of Christiania and Langesund.——*Spangolite* is proposed by Penfield[3] as the name for a hydrated sulphate and chloride of copper, occurring, probably, somewhere in the Globe District, Arizona. The new mineral incrusts cuprite, and is associated with azurite and atacamite (?). It is rhombohedral, with its crystals bounded by oP and a series of pyramids of the second order. The cleavage is perfect parallel to oP. Etched figures produced on the basal plane by the use of dilute acids are bounded by oP and scalenohedral faces. They are all very clear, and all have an undoubted rhombohedral symmetry. By reflected light the mineral is dark green, while by transmitted light it is light green. Pleochroism is slight. The double refraction is strong and negative, with ω=1.694, ε=1.641. Hardness on oP is 2, and on the pyramidal faces 3. Specific gravity is 3.141. The average of four analyses gives:

SO_3	Cl	Al_2O_3	CuO	H_2O
10.11	4.11	6.60	59.51	20.41

corresponding to $Cu_6AlClSO_4+9H_2O$.

BOTANY.

Some Reasons for Varieties not soon Wearing Out.—The direct result of a union of two or more distinct protoplasmic masses, in plant life, is a condensed, inactive, and transportable condition of the life of the species, that is, a seed or spore. Among lower plants this reproductive union usually takes place in the simplest manner, and at times that are determined by unfavorable circumstances for a further continuance of the life of the species in its ordinary rapidly-growing condition. Thus the moulds form their resting spores when the prospects are that resting spores will be most needed to carry the life of the species over the approaching period of cold, drought, or lack of food supply. The uniformity of the coming and going of the seasons has its parallel in the uniformity with which the higher plants produce their annual crop of seeds. In the great struggle for life that is going on, it is perhaps true that some species have found it to their advantage to form their seed early, and long before the time when the season

[3] *Amer. Jour. Science*, May, 1890, p. 370.

of approaching winter should suggest it. It may be that such species have learned by sad experience that with them it is early seeding or none at all.

In the lowest forms of life there is not even the union of protoplasm for the formation of the inactive state. The resting spores of the Bacteria are, as far as we know, ordinary cells, the protoplasm of which is unusually protected by a thick cell wall. As we rise in the scale of plant life, the points of origin of the two protoplasmic elements become more widely separated. In the pond scums (Spirogyra) it may be that the contents of adjoining cells unite to form the zygospore. Among flowering plants this question brings in review the subject of sexual separation, as worked out in the various lines of dimorphism, dichogamy, etc., until we arrive at the dicœcious plants. From the bacterium resting spores, formed out of the contents of a single cell, the two lines diverge until we find their opposite extremities separated by dicœcism; a condition in which for the formation of an offspring, corresponding functionally with the primordial spore, there must be the union of a particle of protoplasm of one community of individuals (tree or herb) with another of a separate and otherwise independent community.

Another parallelism of differentiation may be seen. Among the lower forms of life there is but little variation among the units; the one reflects the other, and species are founded upon differences that are only determined by using the micrometer. The higher types show not only a greater variation in the units, but the communities made up of these have their distinct peculiarities. One white pine or maple is not like all others of its kind.

It may, perhaps, be stated as a rule that where there is the greatest separation of the sexes, within the limits of the law, there is the greatest variation, or the extreme tendency to vary. If the union is between different species, there are new lines of variability bestowed upon the offspring. If this hybrid unites with another distinct hybrid, it is easy to see that the current of tendencies is again made doubly complex, and if the offspring is able to bear the load that the law of heredity throws upon it (now a broken law), the result will be a set of plants almost as easily turned in their course as autumn leaves floating on a sluggish stream.

Reproduction by union is a deeply laid plan among the higher orders of plants. Many plants during one year prepare for its occurrence in the next. Pollen to be shed in the spring is prepared the previous autumn, and the female germ cells are also already made to receive the quickening dust. If we may judge of importance

by complication of structure, the process of bringing distant particles of protoplasm together seems the leading end of many plants. If seeds fail the plant has failed. Perennial plants, and those that are easily propagated non-sexually, are less subject to the law of "union or death" that prevails among annuals and biennials.

Reproduction by union among the lower forms of life is primarily to place the species out of the jeopardy that otherwise might follow untoward circumstances, and also to facilitate its more thorough distribution. When we arrive as high in the scale as the ferns we find that the union takes place once for all in the life of the fern plant, and that the direct and immediate result is not a spore, but a plant upon which the spores are afterwards borne annually in great numbers without further fertilization. Each spore in germination produces a small, delicate scale of cells, the prothallus: one protoplasmic mass, the germ-cell of the archegonium, grows into a fern plant after it has been stimulated by the commingling with it of the male elements. Cases are on record where the fern plant has developed from the prothallus without the intervention of the antherozoids, but they are rare. A few plants may go on for many years producing crops of spores, but it is the rule that it shall not begin this life of spore-bearing until a union has taken place. In the moss the union precedes the formation of each capsule, and each capsule bears a multitude of spores. For the same number of spores it is easy to see that fewer unions are required in the moss than in the pond scum, and more than in the fern. Although this union enters into the plan of reproduction, its influence is far-reaching. Only the mathematician can write the figures representing the number of spores produced by a tropical tree fern through its long existence.

The moulds and low-water plants may rejuvenate by union upon seemingly the slightest provocation. In the moss it means much more than in the lower forms, and in the ferns it means infinitely more. As we pass beyond the cryptogams, and study the flowering plants, may it not be safe to conclude that here, where the structures in the sexual apparatus are vastly more complicated than upon the prothallus, we have results that are correspondingly more lasting? It suffices for the banyan-tree, that covers many acres, and the impulse of fertilization lasts through the lifetime of the oldest trees, which is estimated to be not less than four thousand years. Every seed that falls from the giant red-wood has its spore in the vitality stimulated by the original union. If this be not true, then we are forced to believe that the union was only serviceable, like the starch and oil in the cotyledons, for the initial growth of the seedling. Whatever view we take, the assumption holds

that a union among flowering plants is more significant than with the ferns and allied cryptogams. If this assumption seems reasonable, it is not unsafe to conclude that it is not easy to limit the time that the offspring of any union may exist.

On the same basis it may be asserted that the wider the union the more vigorous the progeny, and the more certain it will be to succeed. This statement rests on a broad basis of fact. Darwin's work on "Cross and Self Fertilization in the Vegetable Kingdom" is a corroboration of the statement, that "Nature abhors continual close fertilization." If the rule be reasonable among weed plants, it will appear even more so among domestic vegetation, in so far as wideness of fertilization is concerned. Nature has but comparatively few varieties. They may take the initial step, but be crowded out, the struggle being oftentimes too fierce. Among cultivated plants the conditions are very different. The plants are removed from the intense action of the law which determines the "survival of the fittest." The weeds are the best fitted to survive, but the hoe befriends the weaker and better (for man) species. Cultivated plants, therefore, lead a life of comparative peace, and their energies are expended along the lines that the cultivator desires to follow. Variations appear, and are carefully watched and propagated, and in time a new sort is established. The conditions are vastly more variable under which cultivated plants exist than those of their wild allies. This leads to a wide range of characteristics even in the same variety. Unions, therefore, are here more powerful, under the rule that wild is more potent than close fertilization. Each individual is the balance-sheet of a long series of forces, both of within and without.

The two controlling laws of life, which for brevity's sake may be stated as: Like produces like, and, like produces unlike, doubtless act everywhere. But the first prevails in the lower forms of plants while the second dominates over the higher. As an extreme instance note the human race with its millions of individuals, no two of which are unmistakably alike. Even here the greatest variations are in the more highly developed classes or nationalities. The type of gentleman is more variable than the type of the Hottentot. The dominant motive of the former is not so constant and all-absorbing as in the latter.

The wild plant exerts all its powers to keep even with its rivals. The cultivated plant has thrown down its arms, and is active in building those structures that are useful to man. To rear young through seed may be lost from sight in part when man is satsified that the labor shall be along other lines. Man becomes the responsible party, and

only the refractory and therefore worthless species will not acknowledge him as master when he treats them like King.

There is therefore a strong argument in favor of the view that cultivated varieties should remain intact indefinitely if conditions for growth remain constantly favorable.—BYRON D. HALSTED, *Rutgers College.*

The Causes of Cypress Knees.—From the teleological standpoint the the buttress function of the cypress knees was ably advanced in the last number of the AMERICAN NATURALIST, and while reading the article it occurred to me that the swaying of the trunk by winds would unavoidably produce a pulling strain upon roots at any angle with the tree, with a tendency to the elongation of such roots, particularly the outermost ones, and with the rebound or push of the tree in the opposite direction there would occur angularities at the points of greatest stress, in such outer roots, with sap exudation at such angles, and the piling up of indurated tissue in such forms as we find in the "knees." Recollecting that Herbert Spencer had dealt with plant morphology in a general way, I looked up the reference, and believe that his Chapter II., Part V., Vol. II., Principles of Biology, covers the subject admirably, especially in the words of Sec. 279: "Many commonplace facts indicate that the mechanical strains to which upright gravity plants are exposed, themselves cause increase of the dense deposits by which such plants are enabled to resist such strains."—S. V. CLEVENGER, *Chicago.*

ZOOLOGY.

Phymosoma.—A. E. Shipley has recently published his complete paper[1] on the anatomy of the West Indian gephyrean *Phymosoma varians*. Above the mouth is the horseshoe-shaped lophophore, which bears a varying number (but always even) of tentacles; below is the vascular lower lip. Both lip and lophophore have a skeleton which gives attachment to the retractor muscles. The nervous system consists of a bilobed brain connected with the ectoderm within the lophophore. This gives rise to three pairs of nerves, one supplying the pigmented tissue of the region in front of the mouth, the second sending branches to the tentacles, while the third, sending a branch on either side of the œsophagus, unites below in the ventral nerve cord, which shows no traces of double origin, and which is not ganglionated. From it arises at intervals a single median nerve, which later divides

[1] *Quarterly Jour. Micros Sci.*, XXXI., p. 1, Apr., 1890.

and forms a circular nerve around the body. The circulatory system is closed. It consists of two plexuses, one in the lophophore, and the other in the lower lip. These are connected with a reservoir or dorsal tube lying on the œsophagus, and at the junction of reservoir and plexuses there is a large blood sinus almost completely surrounding the brain. The animals are dicœcious, the generative organs occurring at the points of origin of the ventral retractors. Mr. Shipley thinks that the evidence presented by Phymosoma lends additional weight to the view that Phoronis should be regarded as related to the Gephyrea inermia.

Molluscs of the Albatross Explorations.[2]—The United States Fish Commission steamer Albatross made collections on her voyage from the Chesapeake through the Straits of Magellan and north to California. Mr. Dall has reported upon part of the molluscs. As might have been expected, the cruise resulted in many novelties and varieties in forms from depths of over one hundred fathoms. The account opens with an interesting discussion of the environments of deep sea life, and its effect upon the molluscan fauna. It is interesting to note that molluscs which belong to phytophagous groups are, from the absence of plant life in the deep sea, obliged to put up with a diet of Foraminifera, and as a result the digestive organs are greatly increased in calibre, the termination of the intestine prolonged beyond the body, so that the fæces are deposited away from the gills. Deep sea mollusc shells are remarkably free from those countersunk holes produced by the radula of carnivorous gastropods, a fact which leads the author to conclude that they do not live in perpetual conflict with each other; that the struggle is against environment rather than against molluscan enemies. The systematic portion begins with the brachiopods (why this association of brachiopods and molluscs?) and then follow acephals and gastropods. In the text are numerous interesting points, among them the fact that the embryos of *Scaphella magellanica* possesses a membranous protoconch, the existence of which explains the peculiar apex of the shell of the adult.

The Organs of Bojanus in the Unionidæ.—Dr. Walter M. Rankin has recently reinvestigated the structure of the organs of Bojanus in *Anodonta cygnea*.[3] The organs are paired, the two being connected by a transverse tube. Each nephridium consists of four portions. A nephrostome leads from the pericardium into the anterior

[2] Proc. U. S. Nat. Mus., XII., 1889 [1890].

[3] *Jenaische Zeitschrift*, XXIV., p. 227, 1890.

end of the glandular portion of the nephridium. This latter portion runs backward beneath the pericardium until it reaches the posterior adductor muscle. It then bends upward and enters a three-chambered portion lying in the angle between the pericardium and posterior adductor. From thence the organ runs forward parallel to the glandular portion, until, at about the level of the nephrostome, the ureter goes downward and outward to the exterior. The histological characters of the different portions are described. In returning from the different portions of the body the blood mostly enters the sinus venosus, but some goes directly to the chambered portion of the nephridium. That which enters the sinus can pass through numerous openings, so as to bathe the external surface of the nephridial cell-walls. By careful maceration with nitric acid, Dr. Rankin traced the nerve supply of the organ, and finds that it receives an anterior innervation from the cerebro-visceral commissures, and a posterior from the visceral ganglion. The question of the taking up of water is discussed. Dr. Rankin describes the valves in the course of the circulatory organs, and thinks that their position and mode of action is sufficient to explain all the phenomena of expansion of the foot, etc., without recourse to the absorption of water.

The Dorsal Papillæ of Nudibranchs.—Dr. W. A. Herdman enumerates[4] three types of projections upon the dorsal surface of the Nudibranch molluscs. These are (1) the dorsal tentacles (Rhinophoræ); (2) the true branchiæ, and (3) the dorsal papillæ (Cerata). The last—Cerata—are regarded as outgrowths of the epipodial ridge, and frequently are considered as organs of respiration. They may be divided into those which contain diverticula of the liver (hepatocerata), and those which are mere outgrowths of the body wall (parietocerata). Dr. Herdman thinks that these cerata play at most but a moderate part in respiration, and thinks this is shown by the fact that they coëxist in many forms along with the true branchiæ, and that in all cases they contain no more numerous blood vascular spaces than does the adjacent skin. On the other hand, he regards them as protective either by causing the animal to resemble closely its surroundings, or, as in the case of Eolis, by making the animal conspicuous, and warning all fishes, etc., to let it alone because of the stinging organs in the cerata. These last are described and figured. The hepatic cæca extend a considerable distance into the tentacle, and then are continued directly into a "connecting tube," which in turn opens into the cnidiphorous sac, which is evidently an invagination of

[4] *Quart. Jour. Micros. Sci.*, XXXI., p. 41, 1890.

the ectoderm, containing numbers of large cells filled with thread cells. Herdman confirms the view, lately disputed, that the hepatic cæca are in communication with the exterior *via* the connecting tube and the external orifice of the cnidiphorous sac.

Zoological News.—General.—C. F. Marshall returns to the discussion of the histology of the muscle fibre.[1] After a discussion of some of the recent literature and a reply to Rollett's criticisms of the network theory, Marshall reaffirms his belief in the view that in rapidly contracting muscles (transversely striated) the portions differentiated to perform the contraction form a regular and highly modified intracellular network the longitudinal fibres of which produce the contractions, while the transverse meshes give the striated appearance to these muscles. He farther describes the development of the network in the trout and rat, and concludes that its transverse portions are directly connected with the muscle corpuscle, the longitudinal with the nerve end. The network developes first at the surface, and extends centripetally, and each muscle fibre appears to be developed from a single cell.

Worms.—*Chætobranchus* is a new genus of Oligochætes described[2] by A. G. Bowman from fresh water of Madras. It is remarkable in having elongate processes (a pair to a segment) on the dorso-lateral portions of the body. These processes diminish in length from before backward, until at about the middle of the body they appear as mere warts upon the surface. As each contains a loop of the lateral blood-vessel as well as a diverticulum of the cœlom (and some of the dorsal setæ) they are regarded as respiratory in function. Reproduction by fission was observed, but no budding zone was recognised.

Arthropoda.—A. D. Michael has been studying the variations in the female reproductive organs of Uropoda,[3] a genus of Acarina. In these forms the ovipositor is replaced by a "vestibule" leading from the vagina to the exterior. This structure is quite complicated, and is surrounded by complex organs. In *U. ovalis* these structures are arranged so that during copulation the spermatozoa pass into the receptaculum seminis, but are prevented from entering the vagina, while later they may be forced into the latter organ. In *U. vegetans* the relations are much the same. In *U. krameri* the vestibule is adapted for stripping the shell from the egg at the time of laying, so that the larvæ emerge from the egg at the time of oviposition.

[1] *Quart. Jour. Micros. Sci.*, XXXI, p. 65, 1890.

[2] *Quart. Jour. Micros. Sci.*, XXXI, p. 83, 1890.

[3] *Jour. Roy. Micros. Socy.*, April, 1890.

Mr. Cecil Warburton, in an interesting study [4] of the spinning habits of the spider *Epeira diadematа,* comes to some conclusions at variance with those usually held. By entrapping spiders while spinning, and then studying the spinnerets with the lens, he finds that the line does not usually consist of many threads fused together, but ordinarily of two or four distinct threads. His paper is supplementary to and to a large part confirmative of a recent one by Apstein. Experimentation of the same kind is easily conducted, and will lead to interesting results.

Cœlom and Nephridia in Palæmon.—W. F. R. Weldon finds [1] that shortly after injecting a one per cent. solution of indigo carmine into the tissues of the prawn, it will be found aggregated in the anterior portion of the thorax. He finds there a cephalothoracic sac extending from the gonad forward to the anterior end of the body, giving off at each anterior angle tubes which connect the organ with the green gland. The structure of this latter differs from Grobbin's account. From the above it appears probable that Weldon has here the long sought Arthropod cœlom, and the conclusive evidence that the green glands are true nephridia. The close connection of the gonad with the cœlomic sac is also suggestive. This goes far toward supporting the views of Lankester and Sedgwick that the cœlom and blood-vascular spaces of the Arthropods are distinct, and that the general perivisceral space of a crayfish or a grasshopper is not to be compared with the body cavity of an annelid or vertebrate.

Fishes.—The results of the deep sea dredging by the U. S. Fish Commission are now being published by the U. S. National Museum. The first paper is by Messers. Goode and Bean, and includes seventy new species. A list of all known deep sea fishes accompanies the description of these. Among the novelties is a new genus of Chimæridæ, which has an extremely elongate muzzle. There are many other interesting forms. The fishes collected by the steamer Albatross are the subject of a report by Prof. C. H. Gilbert. Ninety-six species of this list are new. They are mostly from the Pacific Ocean near the Galapagos Islands.

The expedition to explore the waters of the Valley of the Tennessee, sent by the U. S. Fish Commission under Prof. Jordan, have published their report. They found fourteen new species, the genus most largely represented by novelties being Etheostoma, of which the largest known species, *E. rex* Jord., was obtained. No exploration of this region has been made since that by Prof. Cope in 1869.

[4] *Quart. Jour. Micros. Sci.*, XXXI, p. 29 1890.

[1] *Jour. Marine Biol. Assn.*, No. II., p. 162, 1869.

Reptiles.—Mr. Boulenger figures in the proceedings of the Zoological Society of London the *Python curtus* of Hubrecht, a species long overlooked, but which is widely distributed in Malaysia, continental and insular.

M. F. Bocourt describes and figures in the last number of Mision Scientifique de Mexique the Colubrine snakes of that country, including Pityophis, Spilotes, Coluber, etc. The plates are admirable.

Prof. E. D. Cope describes, in the late Proceedings of the U. S. National Museum, the reptiles and Batrachia obtained during the voyage of the U. S. Fish Commission steamer Albatross around S. America to the west coast of N. America. He rehabilitates the genera Batrachyla Bell, and Nannophryne Gthr., which were founded upon species from Patagonia, describes a new Zachænus from that country, and a new Phyllodactylus and Tropidurus, each from the Galapagos Islands. He shows that in Tropidurus it is the females that are more brilliantly colored than the males, contrary to the rule in the allied genera Sceloporus and Liocephalus. The colors are red, while in Sceloporus they are blue.

Mammalia.—In the Bulletin of the American Museum of Natural History of New York, Dr. E. A. Mearns, U. S. A., describes a number of new Mammalia from Arizona. They are as follows: *Sciurus hudsonius mogallonensis, Fiber zibethicus pallidus, Hesperomys leucopus arenicolus; Sigmodon hispidus arizonæ; Lepus allenii; L. melanotis, Dipodomys merianii; D. chapmanii; and Cynomys arizonensis.*

EMBRYOLOGY.

Prof. Weismann on the Transmission of Acquired Epilepsy.—The chief instance favoring the transmission of acquired characters which Prof. Weismann finds difficulty in explaining is evidently the series of experiments with reference to artificial epilepsy in guinea-pigs performed independently by Brown-Sequard and Obersteiner. I judge that Prof. Weismann himself regards this as the case presenting the greatest difficulties for his theory, since he has treated it in particular twice in the Essays upon Heredity, summarily in pages 81-82, and at length in pages 310-319, written in 1887, and also since he refers to it as "the only definite instance which has hitherto been brought forward in support of the transmission of acquired characters." (P. 319.) Prof. Weismann acknowledges the results of the experiments to be

that various lesions of nervous substance in guinea-pigs are followed by epilepsy, and the offspring are often affected with nervous disorders, and sometimes with epilepsy. He defends his theory in two ways, first, by referring to infection as the true cause, and not heredity (p. 82, pp. 312-315); secondly, by pointing out the difficulty of conceiving the method of transmission upon either a preformation or epigenetic theory (pp. 315-319). Both these lines of argument are, it will be noticed, in the region of hypothesis and supposition.

As to the first point, there is no distinct evidence, as he himself admits, that epilepsy is caused by bacillus; and, in fact, in some cases it cannot be (p. 314), and yet he conceives that the transmission is by a bacillus from an infected part reaching to and attacking germ-plasm. The question here, as often elsewhere in the Essays, is resolved not so much into a matter of fact as a matter for conception. But how does the bacillus hypothesis simplify the problem for the imagination? If the microbe reaches the germ-cell how can it attack it any more than a "molecule of the brain of an epileptic animal?" (p. 310). If it could attack the germ-plasm, we have still the same fundamental difficulty as with transmission of acquired character, namely, as to how the bacillus can excite in the germ, not epilepsy itself, which is impossible, but such a peculiar disturbance of some peculiar molecular order that epilepsy will result after the many stages of evolution in a certain part of a certain tissue in the developed animal. That is, we must bring against the bacillus theory the same objection which he brings against the epigenetic when he asks how the germ-plasm can receive, "not indeed the peculiar structure of the stage itself, but such a molecular constitution as will ensure the ultimate appearance of epilepsy in the offspring." (P. 318). Prof. Weismann concludes that there is transmission, but one "which cannot depend upon heredity, and is in all probability due to infection." But if this method of infection is admitted, do we not have here, in a wide but true sense, heredity, a real transmission of acquired character, the acquired infectious (?) disease is transmitted to offspring; the offspring alike inherit it, whether we suppose the method of transmission to the sperm or germ-cell be by transference of bacillus, or of diseased molecules, or of gemmules, or any other way. By acknowledging that the continuous germ-plasm is affected, no matter how, but by or through acquired character, so that the character reappears in offspring, does not Prof. Weismann really concede the point at issue?

With reference to the second point, the *reductio ad absurdum* of other theories, it is quite possible to urge against the continuity theory

itself many of the same objections which Prof. Weismann brings against the gemmule and epigenetic hypotheses. The inconceivability as to number and complexity of gemmules is quite matched by the inconceivable complexity of a germ-plasm, which in the sixth generation is composed of 32 ancestral germ-plasms, in the tenth generation of 1024, etc., even if the reduction by one-half be accomplished for each generation as explained pp. 357, ff. Moreover, must not each of these germ-plasms be divided by the vast number of ova or spermatozoa which appear in any individual's lifetime, and which are all potential for a possible conception? I am not aware that Prof. Weismann treats this point; but at any rate it is difficult to see how, upon his hypothesis, we can escape getting down within a few generations to the ultimate unit which "cannot be divided without the loss of its essential nature." (P. 357.)

The fundamental difficulty, the causing from a remote part of the organism such a peculiar effect upon the germ that the disease reappears in the developed organism, this problem is unsolved by the bacillus hypothesis, as also by the gemmule and epigenetic hypotheses. But do we need these hypotheses? This must be granted, that the germ-plasm, whether continuous or not, is a living being within the body and also of it (cf., pp. 103, 170, 267, *et passim*); that the law of interdependence of function—disorder in one function exciting sympathetic affections in others—applies to reproduction; that farther, the reproductive function is specially sensitive to nervous disease, as nervous exhaustion, for instance, which causes mutilated spermatozoa, and so weakens for future development. Moreover, specific causes will produce each its particular effect upon the germ for its whole development. But does this sympathetic affection need to be conceived as actual transference of bacillus or gemmule? May it not rather be regarded as a dynamic response in a dynamic whole, a transference of abnormal motion rather than matter? It seems probable that epilepsy, for example, could cause specific changes in the germ, but this may not be heredity, which is a specific effect of such a nature as to bring about this special disease in the offspring after many and diverse stages of evolution. It is certainly most difficult to conceive how this telepathy can be secured, but it is always to be remembered that at bottom it is a question of fact rather than conception. By a series of experiments we must trace the effects of nervous disorder upon spermatozoon and ovum, and how this effect is carried through conjugation and development.

It would be rash in our present knowledge to say that all influences made upon the germ are of the transmitting type; but as to this case of artificial epilepsy we may affirm that such evidence as we have points to general and even special heredity of acquired character through some affection of the germ produced by that character. A nervous disorder, epilepsy, tends to produce in offspring some nervous disorder. It is plain that if there is any effect upon the offspring from this disease, it is upon the nervous tissue rather than upon any other tissue or function, and this deserves to be called general heredity; and so far as the special disorder is communicated, this may be called specific heredity. If a nervous disease tends to produce in offspring nervous disease of any kind, this is so far heredity.

It seems to me, then, that Prof. Weismann's theory of non-transmissibility of acquired character fails even when tried by his own presentation of this test case, but it is certainly to be desired, as he intimates (p. 82) that the series of experiments should be carefully and thoroughly followed up. We certainly owe much to Prof. Weismann's hypothesis, but it is not too much to say that it is still unproved in point of fact, and unsatisfactory as yet to the scientific imagination, at least so far as artificial epilepsy is conserved.—HIRAM M. STANLEY.

ARCHÆOLOGY AND ETHNOLOGY.[1]

Prof. F. W. Putnam, Curator of the Peabody Museum of American Archæology and Ethnology, in Cambridge, closes his last report in the following manner:

"Thus there are the following elements to be taken into consideration in any endeavor to trace the present North American tribes and nations back to their origin. First, small, oval-headed, paleolithic man. Second, the long-headed Eskimo. Third, the long-headed people south of the Eskimo. Fourth, the short-headed race of the southwest. Fifth, the Carib element of the southeast. All these elements must be studied with their differences in physical characteristics, in arts and in languages. From a commingling of all, with greater or less predominance of one over the other, uniting here and subdividing there, through many thousand years, there has finally resulted an American people having many characteristics in common, notwithstanding their great diversity in physical characteristics, in arts, in customs and in languages. To

[1] This department is edited by Thomas Wilson, Esq., Smithsonian Instiution, Washington, D. C.

this heterogeneous people the name Indian was given, in misconception, nearly four hundred years ago, and now stands as a stumbling-block in the way of anthropological research; for under the name resemblances are looked for and found, while differences of as great importance in the investigation are counted as mere variations from the type.

"It is in such museums as this at Cambridge that the facts are now being gathered, and we may hope in time to be able to determine aright the complicated history of the ancient people of America."

Without sanctioning the classification of human races in North America, adopted as above by Prof. Putnam, I cite with commendation and approval the idea expressed in the last paragraph. The average archæologist of the United States has been in times past but little more than a collector of Indian relics. He sought to gather or obtain rare or handsome objects, and these qualities measured their value in his eyes. Such collections, viewed from the standpoint of the real archæologist, are of but little if any value. Their real service to the science of archæology begins when they shall be put to the use suggested by Prof. Putnam; when, in either large or small collections, better in the former, they can be spread out, assorted, classified and divided, they may assist in determining the races of people, as has been attempted by Prof. Putnam in the foregoing paragraph.

Classification of Arrows or Spear-heads or Knives in the National Museum.—Collectors of Indian relics have gathered in all times past quantities of arrow-heads, called "flints," but usually without any attempt at classification or arrangement. The National Museum has sought to make a classification by which these implements may be recognized and described. Such an attempt was made some years ago, but the divisions were so close and the distinctions so finely drawn that it was scarcely possible to follow them. It made so many classes that one could not remember them all, nor identify to which one a given object belonged. In the classification just made the divisions have sought to be broadened and the lines between them deeply drawn and easily recognized. It is as follows:

STONE ARROWS OR SPEAR-HEADS OR KNIVES.

Class—Leaf-shaped—Sub-class A. Thin and finely-chipped implements of the form of a laurel leaf—elliptical and pointed at both ends. They correspond substantially with the French Solutreen type of the Paleolithic period of the Stone Age.

Sub-class B. These may be thicker and ruder than Sub-class A. Some are more oval, and the bases are not pointed, but are either

straight or convex. This class includes the leaf-shaped argillite implements found by Dr. Abbott in the Delaware river gravels at Trenton, N. J.

Sub-class C. Long, thin blades, with nearly straight edges, more like a dagger or poignard. The base may be either convex, straight or concave. Many of them show traces of attachment to a handle by means of bitumen or gum. They are peculiar to the Pacific Slope.

Triangular.—This class includes all forms approaching a triangle, whether the bases or edges be convex, straight or concave. They are without stems, and, consequently, without shoulders, but in some specimens the concavity of the base produces barbs.

Stemmed.—This class includes all varieties of stems, whether straight, pointed or expanding, and all varieties of bases and edges, whether convex, straight or concave.

Sub-class A. Lozenge-shaped.

Sub-class B. Shouldered, but not barbed.

Sub-class C. Shouldered and barbed.

Note. Nearly all of these convex bases are smooth, as though they had been worn. The purpose or cause of this is unknown.

Peculiar forms.—These have such peculiarities as distinguish them from all other classes, but by reason of their restricted number or locality can scarcely form a class of themselves.

Sub-class A. Beveled edges. The bevel is almost always in one direction.

Sub-class B. Serrated edges.

Sub-class C. Bifurcated stems.

New Archæological Discoveries.—These seem to be made in every land with about equal frequency. I have wondered if the average archæologist (I do not expect it of mere collectors) has ever thought of the evidence afforded by the number of these discoveries as to the length of time of prehistoric human occupation, or the density of the prehistoric population. As mere finds of stone hatchets or arrow-heads, spear-heads or knives, bits of pottery, shell, bone, etc., these discoveries are regarded by the finders as of value only to the amount of money for which the objects can be sold. This value is practically nothing compared with what it might be to science if the locality, conditions, association of the objects when found, were accurately noted and truthfully recorded, so as to be used in making up the history of prehistoric man.

Archæologic or Archæological.—Which is correct, or are both correct? Is there any difference in their meaning, or any distinction in the phrases or senses in which they can be used? If both words mean exactly the same thing, why not discard one or the other, and why use them indifferently?

Human and Animal Remains.—(Dr. J. L. Wortman).—The proper collection and preservation of human and animal remains is important. Not infrequently, material of high scientific value is allowed to perish through lack of knowledge of effective method of preservation. Some of the methods are so crude, and the skill of collectors so primitive, that the material when collected is almost worthless. Many remains looked upon by the inexperienced as hopelessly decayed, can, in the hands of the experienced collector, be made of interest and importance to science.

It is a popular error that the anatomist can restore or reconstruct a skeleton from a few scattered fragments. Where the structure of the animal is known this may be done, but with imperfectly known species the entire skeleton is indispensable to a complete knowledge of its osteology. This is true of the human species for the determination of these racial differences or affinities displayed in their skeletons. For these purposes not only one, but many skeletons may be required, and it should be the object of the collector to provide the requisite material, and in such a condition as to be of the highest possible scientific value.

The best method of procedure is perhaps open to question. It depends upon a variety of conditions, such as character of matrix or soil, the condition of the skeleton, its state of preservation, mode of burial, etc. The best method of precedure can only be indicated in a general way. Suppose a skeleton rather friable, buried in loose, dry earth. How shall he proceed? Unnecessary and dangerous explorations with the coarser instruments, such as pick and shovel, must be avoided. Approaching the skeleton, he should explore it with care, using some small instrument, say a hand-trowel. He should make due allowance for the prominences, as the anterior superior curve of the spine, possibly the ribs, as they are frequently found in their natural position; the frontal eminence of the skull, etc.

After the superimposed earth has been removed, cut a trench a foot or so deep on either side of the skeleton, at enough distance to avoid injury to any of the bones—this for convenience in removing the earth from around the bones. Begin at either the head or feet, and remove the dirt bit by bit with the trowel, supplemented by small scrapers of

wire flattened and ground to a chisel edge. These will be useful in cleaning out the cavities. The earth can be brushed away, and the specimens kept clean for observation, using softer brushes as required, so that no injury may be done to the bones. If the specimen crumbles upon exposure to the air, so as to endanger its safety, expose only a small surface of the bone at a time, apply the preservative, and let it dry, after which a little more can be exposed, and so continued until the skeleton is finished.

If the bones are in a fair state of preservation, an entire skull, or, for this matter, the whole skeleton, may be exposed, cleaned with the brush, and the preservative applied. Before applying the preservative remove the dirt thoroughly from the surface of the bone. If this is neglected the preservative when applied will cause the dirt or earth allowed to remain to adhere so firmly that it cannot afterwards be removed without serious damage to the specimen.

Take a skull, for example, part of a skeleton buried in its natural position. One would begin, say at the forehead, and remove the dirt, little by little, until the whole is more or less exposed, using the small implements according to necessity ; and so continuing, with care that the bone is not broken, until the whole is neatly and thoroughly cleaned. It is a good practice to leave the dirt in the deeper parts of the cavities, such as the nose, the deeper parts of the orbits, etc. Next use the preservative, giving a thin coat upon the more exposed portions, avoiding for the present the uncleaned cavaties, that no dirt may be cemented to any portion of the bone. After the preservative is well dried remove the skull from its bed, taking special pains to avoid breaking it. Next remove the lower jaw, being watchful that none of the teeth are lost, clean the cavities and the interior, and finally paint it thoroughly both inside and outside with the preservative.

In the vicinity of where the root of the tongue has been will generally be found the hyoid or tongue bone or bones. In the adult or aged person they generally consist of one piece, somewhat in the form of the letter U, but in the young, and sometimes in the old, they consist of separate pieces. They should always be preserved with the greatest care, and placed with the skull to which they belong. The collector should familiarize himself with their appearance, either by examining a recent skeleton or by consulting some standard work upon human anatomy. This method can be continued for the rest of the skeleton, and can be employed for other animal remains.

The preservative which has proved best in my hands (and I speak from a large experience with almost all known material) is the ordinary shellac dissolved in commercial alcohol. The first coat or two I use tolerably thin so that the porous bone may take it up. It may be found necessary to use several coats before the specimen can be handled, and it is always best to finish off with a thick solution. The judgement and experience of the collector must be his guide in this matter, as it is impossible to lay down any definite rule.

Notwithstanding many coats of shellac the articular extremities of the long bones may be still friable, while their shafts are moderately strong. This I have been able to remedy by plunging them (the articular ends) into hot wax. The wax should not be too hot nor should they be left in too long. A minute or two is enough for their complete saturation. It may also be necessary to give the bodies of the vertebræ and the weaker parts of the innominate bones to a similar treatment.

The foregoing description applies to skeletons buried in dry earth. Where it is damp or wet no attempt should be made at removal until the earth is dry. All but two or three inches of the super-imposed earth can be removed, and left for a few days' sunshine to put it in proper condition. Loose teeth or fragments of bone should be carefully gathered up, wrapped in separate packages and placed with the skeleton. Every bone should be preserved and nothing thrown away.

Instructions for the proper packing and shipment of skeletons can be briefly stated as follows: Number each skeleton and pack it in a separate box. If the skull is unusually liable to breakage it is a good plan to provide a separate box for it also, but it should bear the same number as the skeleton to which it belongs. It will be found that the best material for packing is either soft paper, chaff, or very soft straw or hay, and after each layer sift the interstices *full* of sawdust or bran. This, if well done, will prevent all movement or shaking of the specimens. Breakage of this kind is fatal, and generally results in permanent injury to the specimen.

What has been said as to the preservation of human remains applies more to skeletons buried in mounds or graves, and surrounded by loose soil. In the case of cave burial the bones are generally surrounded by or enclosed in a hard lime cement, which cannot be removed except with hammer or chisel, requiring the appliances and skill of a well-appointed laboratory. In all cases of this kind it is best to take the specimen out in a block of the matrix if possible, and pack as before directed, and ship it in this condition.—J. L. WORTMAN.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Boston Society of Natural History.—March 19th.—Dr. H. V. Wilson read a paper, On the Formation of the Alimentary Canal and the Lateral Line in Teleosts. Photographs of the spinning work of spiders were exhibited by Mr. Horace P. Chandler, and remarks on the same were made by Mr. J. H. Emerton.—J. WALTER FEWKES, Sec.

Biological Society of Washington.—April 19th.—The following communications were read: Dr. W. H. Dall—Exhibition of Original Drawings of the Fur Seal and Steller's Sea Cow, executed by a member of Behring's Expedition of 1742; Dr. C. Hart Merriam—Historical Review of the Faunal and Flora Divisions that have been proposed for North America; Prof. Jos. F. James—On Variation, with special reference to certain Paleozoic Genera; Mr. B. T. Galloway—Observations on the Flora of Missouri; Mr. C. L. Hopkins—Characteristic Vegetation of the Cliff Dwellers Cañon near Flag Staff, Arizona.

May 3d.—The following communications were read: Dr. Robert Reyburn—The Life History of Micro-organisms, with its Relation to the Theory of Evolution; Dr. George Vasey—A New Grass Genus; Prof. W. H. Seaman—The Place of Biology in Public School Instruction; Mr. F. A. Lucas - The Present Status of the Aurochs.

May 17th.—The following communications were read: Dr. Erwin F. Smith—A New Species of the Genus Aphis; Mr. T. S. Palmer—Some Early Views of the Geographical Distribution of Species; Mr. Frederick W. True.—Exhibition of a Specimen of *Lophiomys imhausii*, a rare and remarkable Rodent from Africa; Prof. W. H. Seaman—The Place of Biology in Public School Instruction.—FREDERICK A. LUCAS, Secretary.

Archæological Association of the University of Pennsylvania.—April 25th.—Dr. C. C. Abbott, Curator of the Museum, read a paper on Implements from the Workshop of a Prehistoric Coppersmith.

The Indiana Academy of Science began its spring meeting at Greencastle, Indiana, Thursday evening, May 8. Prof. C. A. Waldo presided. Prof. C. Leo Mees delivered an address upon "Inertia, with reference to Electricity." Friday was devoted to an excursion to Fern Cliff, an interesting region some miles from Greencastle. In the evening a number of short accounts were given of the experiences of the day, with discussion of the local natural history. The speakers were Profs. J. C. Arthur, C. A. Dryer, C. W. Hargitt, Stanley Coulter, D. H. Campbell, C. A. Waldo, and O. P. Jenkins. Dr. J. P. D. John

presided. Saturday the members visited Eel River Falls. The Academy was hospitably entertained by the citizens of Greencastle.

Chicago Academy of Sciences.—April 8th.—Lieut. F. M. Beall, Signal Officer U. S. A., presented a paper: "The Recent Cyclone and its Attending Tornadoes."—C. E. WEBSTER, Recorder.

Proceedings of the Natural Science Association of Staten Island.—April 10, 1890.—Mr. Ira K. Morris presented a brass spur, of Spanish fashion, which was lately plowed up on the Poor House farm, and read the following paper in connection with it:

This spur was found by one of the workmen on the county farm, while ploughing, in February last. It is composed of solid brass, and the wheel must have originally been at least one and a-half inches in diameter. Much surprise is expressed by Staten Islanders at the finding of a spur of its pattern in such an out-of-the-way place. Yet, it seems possible to trace its simple history.

During the Revolution there stood a small Holland cottage, built of stone, and with long, sloping roof, on or near the spot where the County Alms House is now located. The story is handed down to us that it was occupied by a sturdy patriot whose open hatred for royalty and whose unfriendliness to the British soldiers gave considerable annoyance to General Howe, who directed that a guard must be placed upon the premises until some breach should be committed sufficient to cause his arrest.

The mounted patrol of the Island was under the command of Lieutenant-Colonel Simcoe, of the "Queen's Rangers," and it is said that that notorious officer frequently visited the old cottage, not so much to test the loyalty or watch the movements of its owner, as to enjoy the companionship of his beautiful daughter.

Colonel Simcoe did not dress strictly in accordance with the British army regulations, and I have seen a portrait of him in which he wore the Spanish spur, with its large wheel. Appreciating, as he must have, the superiority of this spur over the small, fine wheel worn by the Englishmen, it is only reasonable to assume that his men were provided with it also. During the exciting period following the earnest appeal of Colonel Aaron Burr to General Washington, to besiege the fortifications on Staten Island, especially at "Richmond towne," a detail of Simcoe's mounted men was made daily for many months. Skirmishes frequently occurred near the old cottage, between American troops from New Jersey and the "Rangers" and their native Tory friends.

It was near the close of the war that the severest, and from what we now know, the last skirmish occurred in that vicinity. During a severe storm, and under the cover of intense darkness, a detachment

of Americans crossed the Kills, and losing their way, wandered about for some time until attracted by a light in the window of the old cottage. Simcoe's men were lurking about the premises at the time, and listened to the directions given by its occupant concerning the whereabouts of the British soldiery.

As soon as the Americans had departed Simcoe's subordinate entered the cottage and informed the unfortunate man what he had seen and heard, at the same time stating that he had authority to execute him without trial or delay. The man appealed for mercy until he could acquaint General Howe (who was renowned for his leniency and kindheartedness) of the facts, and the daughter prayed for an interview with Colonel Simcoe, whom she believed would save her father's life. But justice and mercy were unknown among the brutal "Queen's Rangers," from the Lieutenant-Colonel down to the humblest private; yet they well suspected the influence that the pretty girl might exercise under the existing circumstances. As "murder" and "plunder" were ever the watchwords of that infamous organization, there seemed to be no time to lose. The guard drew near, with the exception of the pickets, and, with the assistance of ever-willing Tories, all the occupants of the cottage were pinioned to their chairs. The husband and father was taken out to a tree, a rope quickly placed around his neck, and in a few seconds he was suspended from a limb, and his soul was hurled into eternity. The tree on which this execution took place stood in front of the old "farmer's house" on the county farm, and I once conversed with an an old Staten Islander who remembered it well. Decayed and worm-eaten, it could no longer bear its own weight, and it fell to the ground in a terrible wind storm that swept over the Island about 1827.

The "Spanish" spur, as it is called to day, and of which this relic is a fair specimen, is not an invention of the Spaniards. In a cumbrous form it bears equal date with the establishment of battle armor, such as was used by the Egyptians considerably more than ten centuries before the Christian era. During the Crusades—the third, if I mistake not—the spur was "remodeled" by order of Cœur de Lion, and made in the exact style of the relic here presented. About two centuries ago the "changers of fashion" thought it too heavy for light riding, and the English spur, with its small wheel and thin footpiece, was substituted. In Spain and other European countries, as well as in Mexico and the Western States of our own country, the Spanish spur is used almost exclusively.

Although there is a popular belief to the contrary, it is far less "cruel" than the fine English spur. A horse once well broken to its

use need only to hear the familiar "clink," "clink," as his rider paces beside him, before mounting, to go for half a day at a time without necessitating its use.

It is with pleasure that this relic, mystical though its history may be, is presented to the Association. While its true story may never be told, it is nevertheless safe to assume that it played its part in the grand drama that shook the world in "the days that tried men's souls.

A specimen of the violet spotted salamander (*Amblystoma punctatum*) was shown, in which the tail was bifurcated, each branch being about half an inch in length. It was captured by Mr. John Tynan in the Snug Harbor woods, and presented to the Association.

SCIENTIFIC NEWS.

The next meeting of the British Association will be held at Leeds, in week commencing September 3d, under the Presidency of Sir Frederick Augustus Abel, C.B., D.C.L., D.Sc., F.R.S., V.P.C.S.

The general Committee will meet on Wednesday, the 3d of September, at 1 P.M., for the election of sectional officers, and the despatch of business usually brought before that body. On this occasion there will be presented the report of the Council, embodying their proceedings during the past year. The General Committee will meet again on Monday, September 8, at 3 P.M., for the purpose of appointofficers for 1891, and of deciding on the place of meeting in 1892. The concluding meeting of this Committee will be held on Wednesday, September 10, at 1 P.M., when the report of the Committee of Recommendations will be received.

The first general meeting will be held on Wednesday, the 3d of September, at 8 P.M., when the President will deliver an address; the concluding meeting on Wednesday, the 10th of September, at 2.30 P.M., when the Association will be adjourned to its next place of meeting.

At two evening meetings, which will take at 8.30 P.M., discourses on certain branches of science will be delivered.

There will also be other evening meetings, at which opportunity will be afforded for general conversation among the members.

SECTIONAL MEETINGS.—The sections are: A, Mathematical and Physical Science; B, Chemical Science; C, Geology; D, Biology; E, Geography; F, Economic Science and Statistics; G, Mechanical Science; H, Anthropology.